# *1979 U.S. Office of Technology Assessment, "The Effects of Nuclear War" deceptions*

**Table 14.—Long-Term Radiation Effects From Nuclear Attacks**

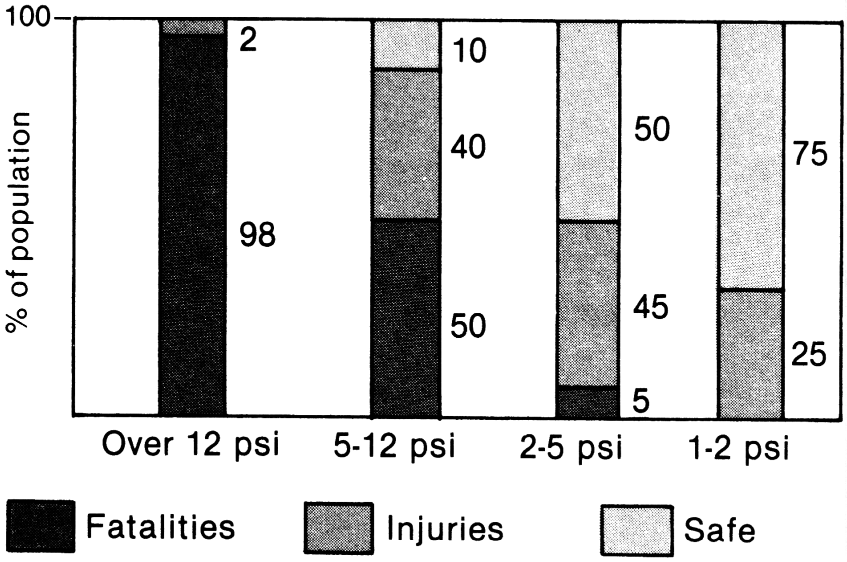
Estimated worldwide[b] effects from 1-Mt air burst over a city (OTA Case 1):

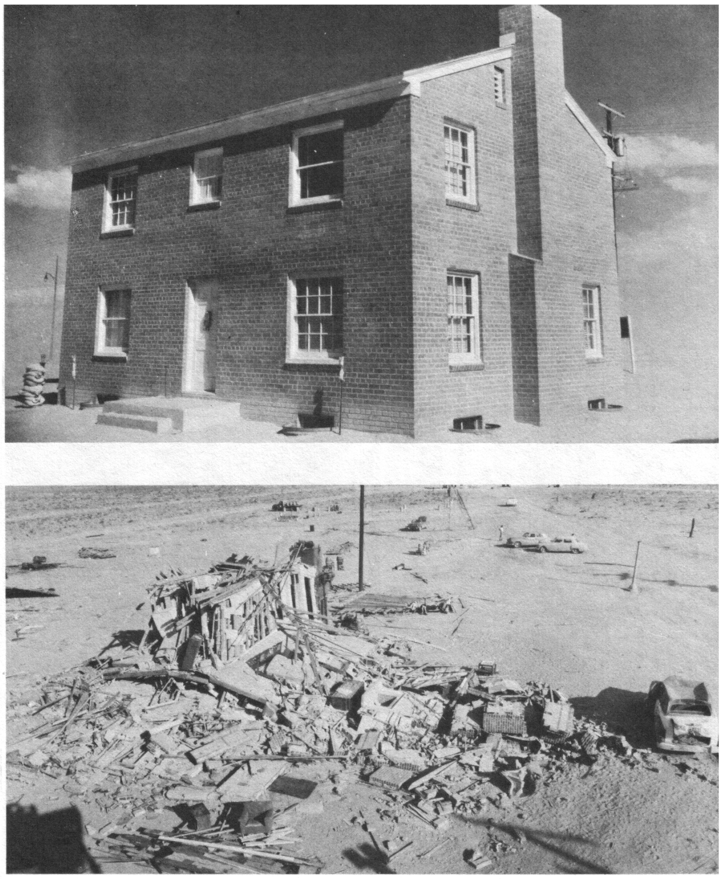
| | |
|---|---|
| ***Somatic effects*** | |
| Cancer deaths | 200 - 2,000 |
| Thyroid cancers | about 700 |
| Thyroid nodules | about 1,000 |
| ***Genetic effects*** | |
| Abortions due to chromosomal damage | 100 - 1,000 |
| Other genetic effects | 350 - 3,500 |

[b] Most worldwide fallout would be in the Northern Hemisphere

## *Above: false LNT radiation scaremongering*

**Figure 1.—Vulnerability of Population in Various Overpressure Zones**



**Damage to unreinforced brick house (5-psi overpressure)**

## *Above: false house collapse (Apple-2 test house after manually demolished!) photo. In fact, outer walls exploded but 1st floor did not collapse at 5 psi, and outward debris motion reduced hazard!*

## *Blast exaggeration:*

**Table 4.—Casualty Estimates (in thousands) (1 Mt on Detroit)**

| Region (mi) | Area (mi²) | Population | Fatalities | Injuries | Uninjured |
|---|---|---|---|---|---|
| 0-1.7 | 9.1 | 70 | 70 | 0 | 0 |
| 1.7-2.7 | 13.8 | 250 | 130 | 100 | 20 |
| 2.7-4.7 | 46.5 | 400 | 20 | 180 | 200 |
| 4.7-7.4 | 102.6 | 600 | 0 | 150 | 450 |

## *Exaggerated blast effects table ignores modern city concrete buildings which resist blast collapse*

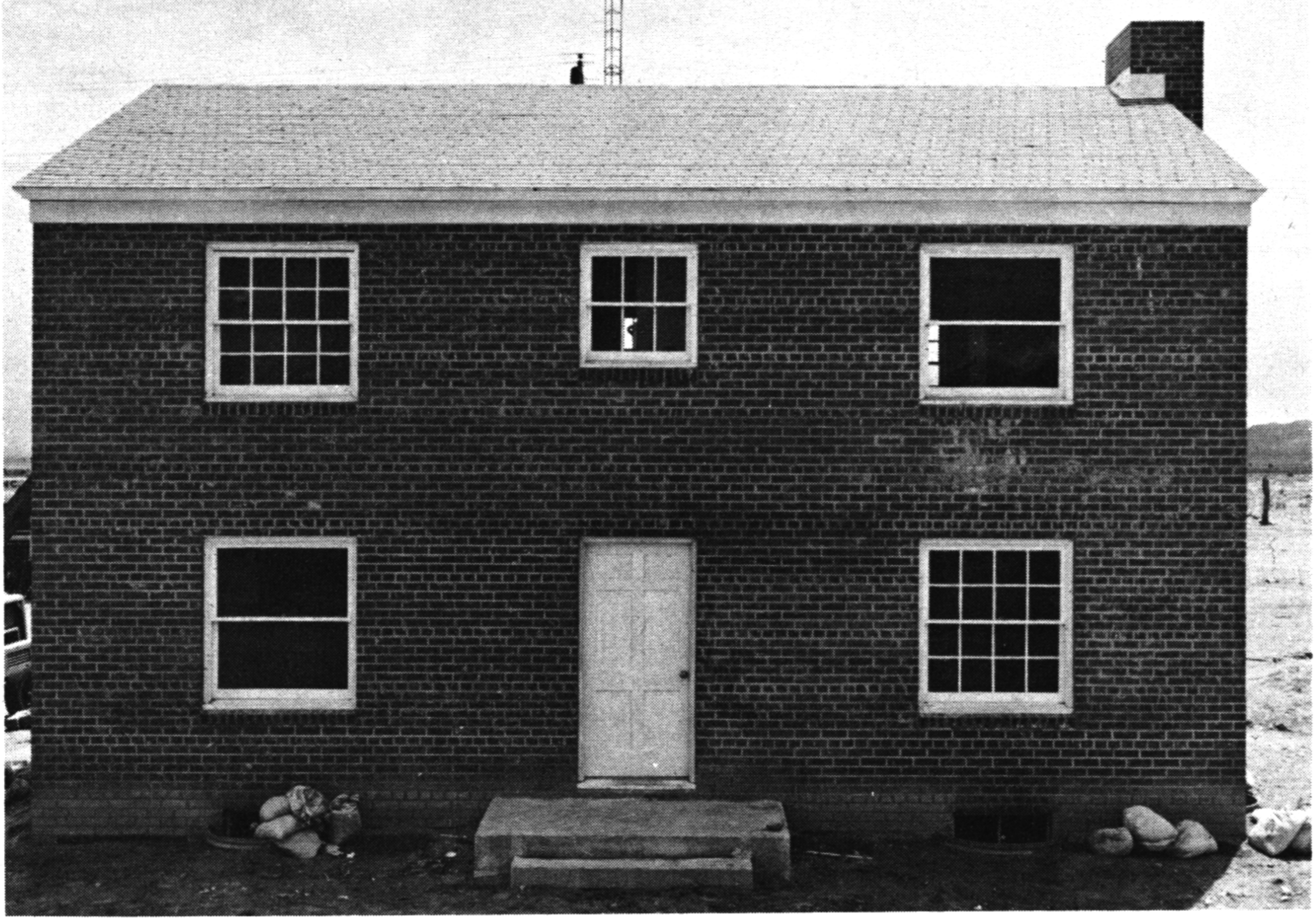
**Table 5.—Burn Casualty Estimates (1 Mt on Detroit)**

| Distance from blast (mi) | Survivors of blast effects | Fatalities (eventual) 2-mile visibility | Fatalities (eventual) 10-mile visibility | Injuries 2-mile visibility | Injuries 10-mile visibility |
|---|---|---|---|---|---|
| (1 percent of population exposed to line of sight from fireball) | | | | | |
| 0-1.7 | 0 | 0 | 0 | 0 | 0 |
| 1.7-2.7 | 120,000 | 1,200 | 1,200 | 0 | 0 |
| 2.7-4.7 | 380,000 | 0 | 3,800 | 500 | 0 |
| 4.7-7.4 | 600,000 | 0 | 2,600 | 0 | 3,000 |
| Total (rounded) | | 1,000 | 8,000 | 500 | 3,000 |
| (25 percent of population exposed to line of sight from fireball) | | | | | |
| 0-1.7 | 0 | 0 | 0 | 0 | 0 |
| 1.7-2.7 | 120,000 | 30,000 | 30,000 | 0 | 0 |
| 2.7-4.7 | 380,000 | 0 | 95,000 | 11,000 | 0 |
| 4.7-7.4 | 600,000 | 0 | 66,000 | 0 | 75,000 |
| Total (rounded) | | 30,000 | 190,000 | 11,000 | 75,000 |

These calculations arbitrarily assume that exposure to more than 6.7 cal/cm² produces eventual death, and exposure to more than 3.4 cal/cm² produces a significant injury, requiring specialized medical treatment.

## *Exaggerated thermal burns table "arbitrarily" assumes 6.7 cal/cm$^2$ is lethal and 3.4 cal/cm$^2$ hospitalizes.*

## *This was not true even for light clothing in Hiroshima and for bigger yields even more heat is needed! Skyline shadowing protects over 90%.*



**29 kt Teapot-Apple 2 test, 5 psi peak overpressure**

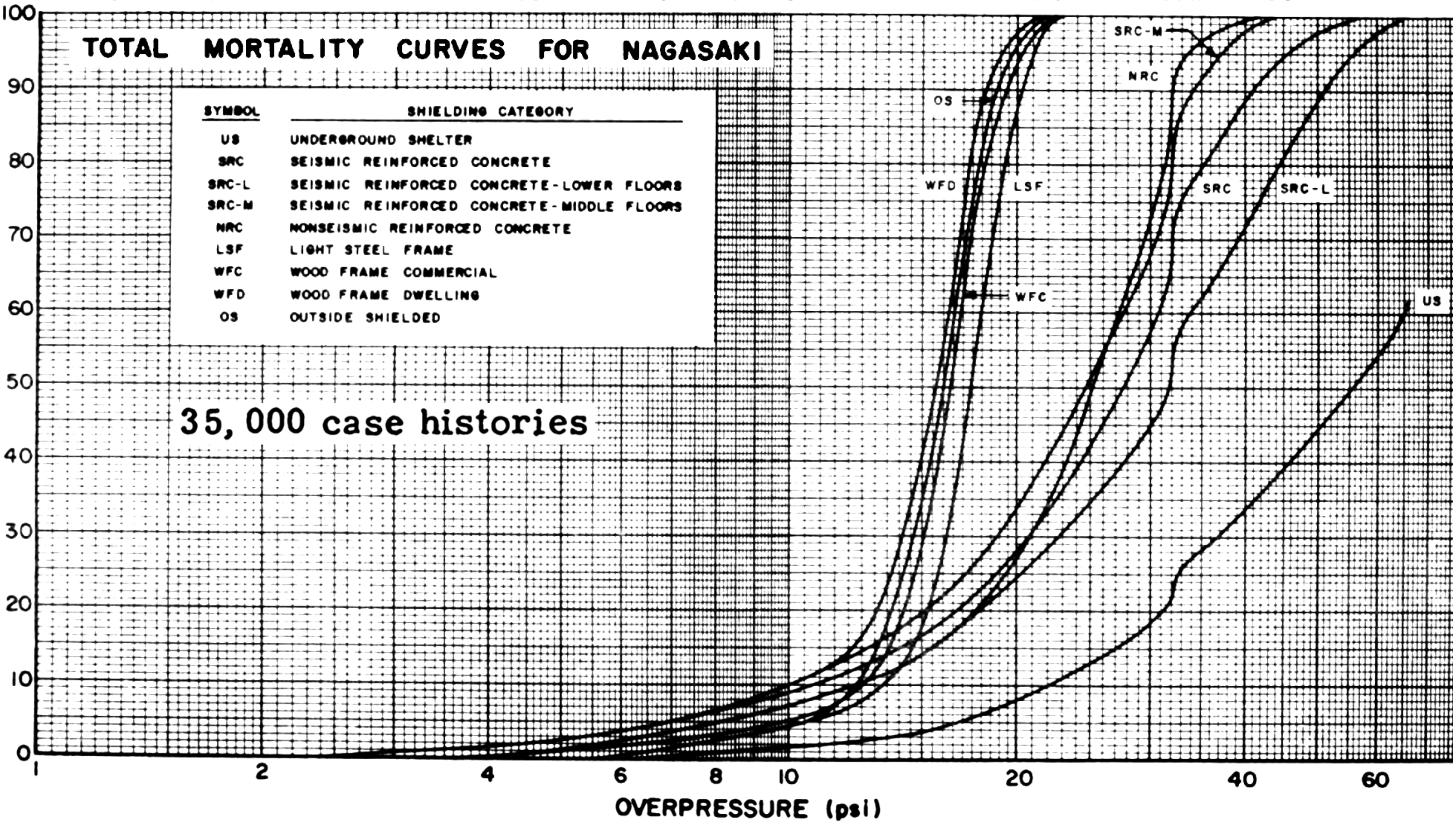
exterior walls were exploded outward, so that very little masonry debris fell on the floor framing. The roof was demolished and blown off, the rear part landing 50 feet behind the house.

**S. Glasstone, Effects of Nuclear Weapons, 1964, p208**

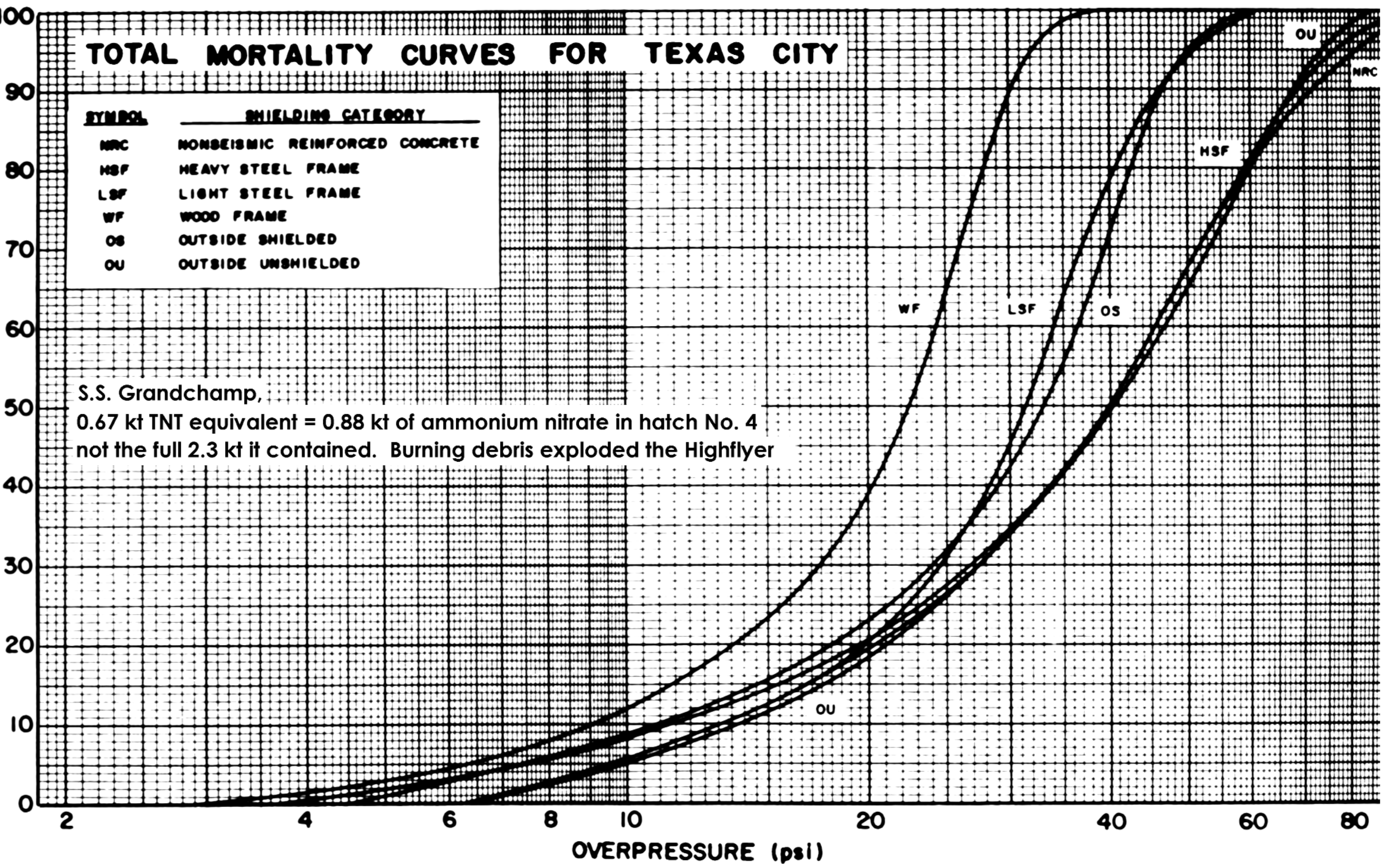
**Wall brick debris was blown out, not in on to people!**

L. Wayne Davis, Donald L. Summers, William L. Baker, and James A. Keller, Prediction of Urban Casualties and the Medical Load from a High-Yield Nuclear Burst, DC-FR-1060, The Dikewood Corporation

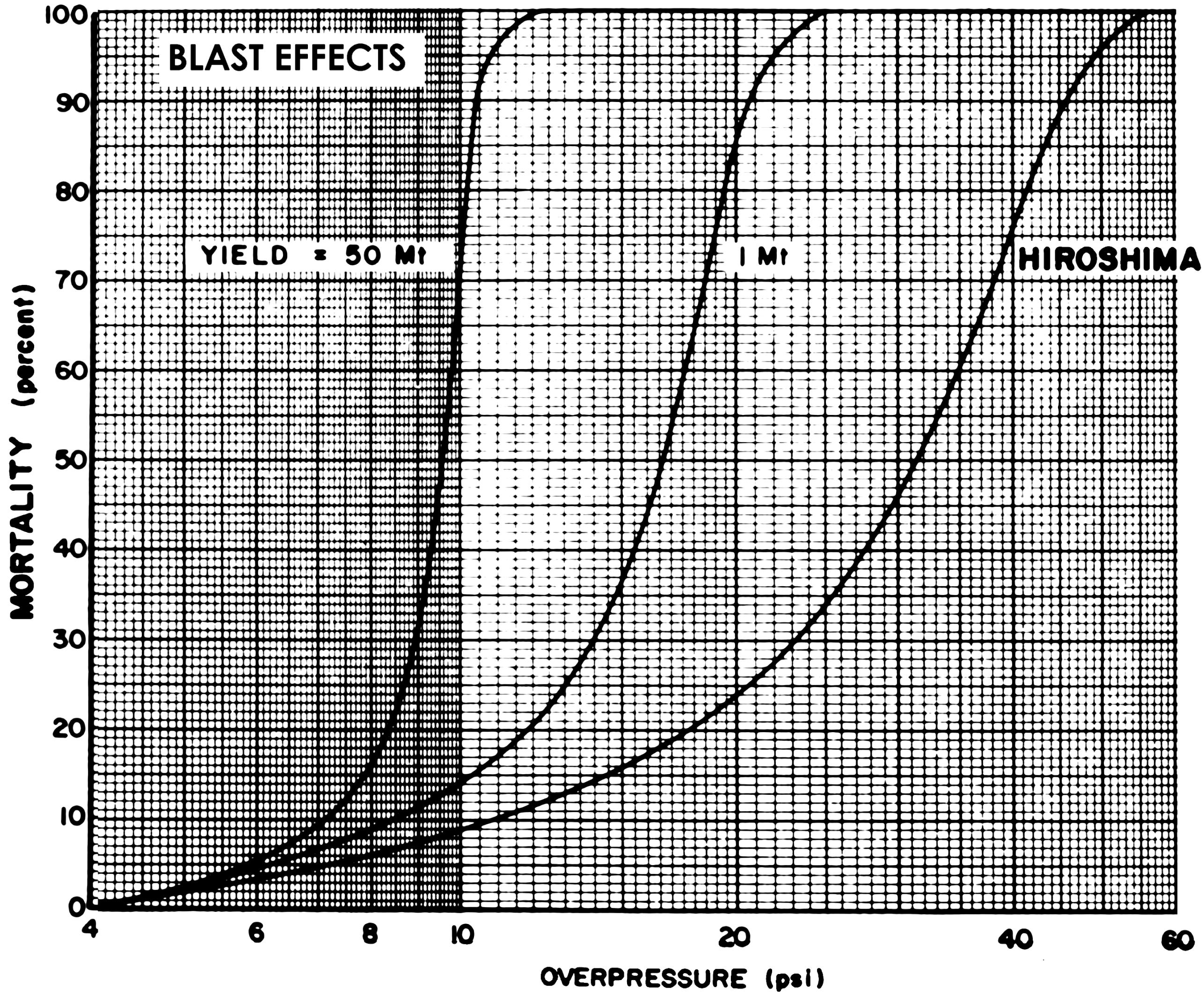
**For people in or shielded by structures in Japan, the blast and initial-nuclear radiation were the dominant immediate effects.**



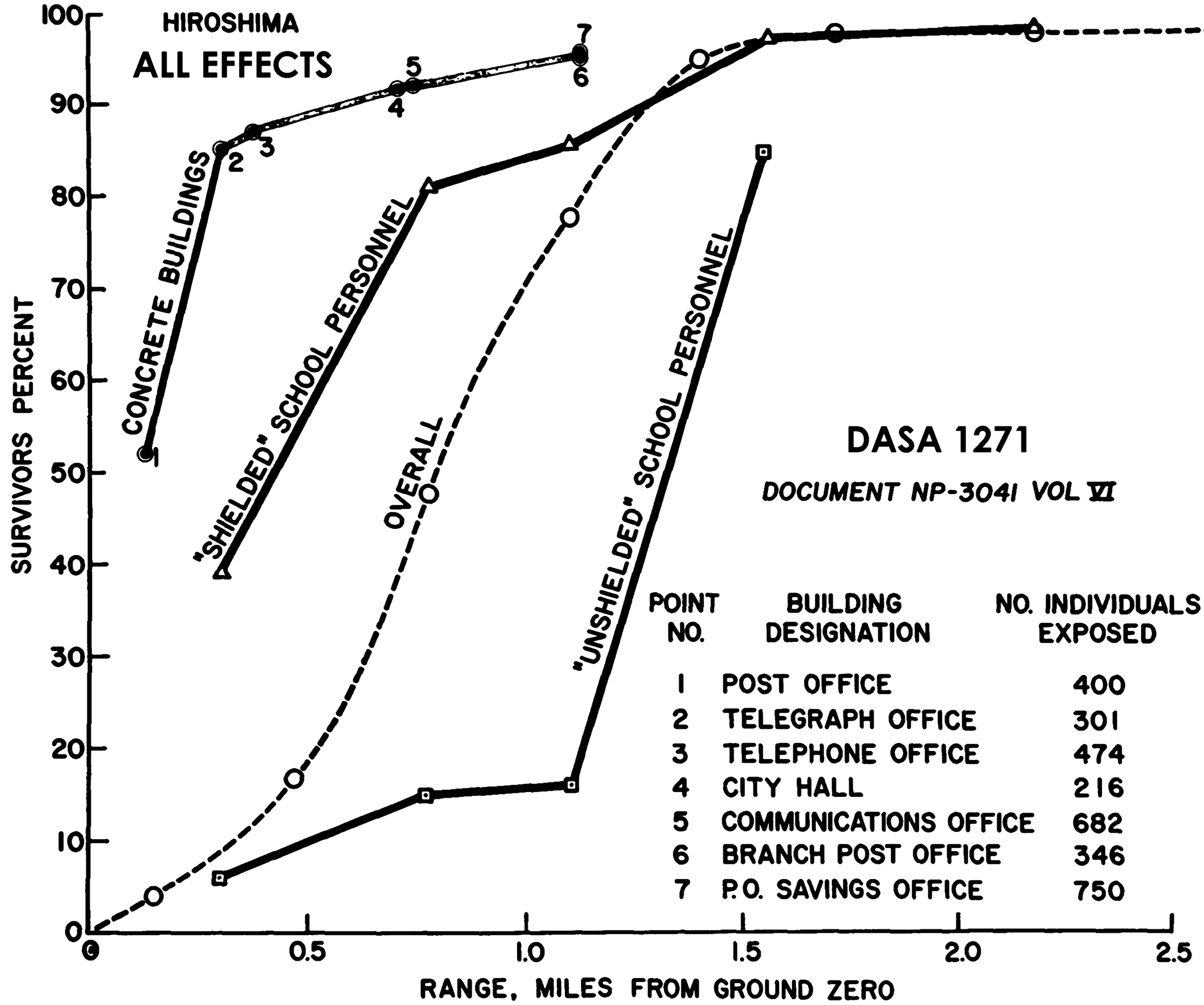

**S.S. Grandchamp at Texas City exploded in 1947. It contained 2.3 kt of ammonium nitrate in 100-lb paper bags, but only the 0.88 kt in No. 4 hatch was tamped and exploded after catching fire. TNT equivalent was 0.67 kt.**



DC-P-1060 **NONSEISMIC REINFORCED-CONCRETE BUILDINGS**



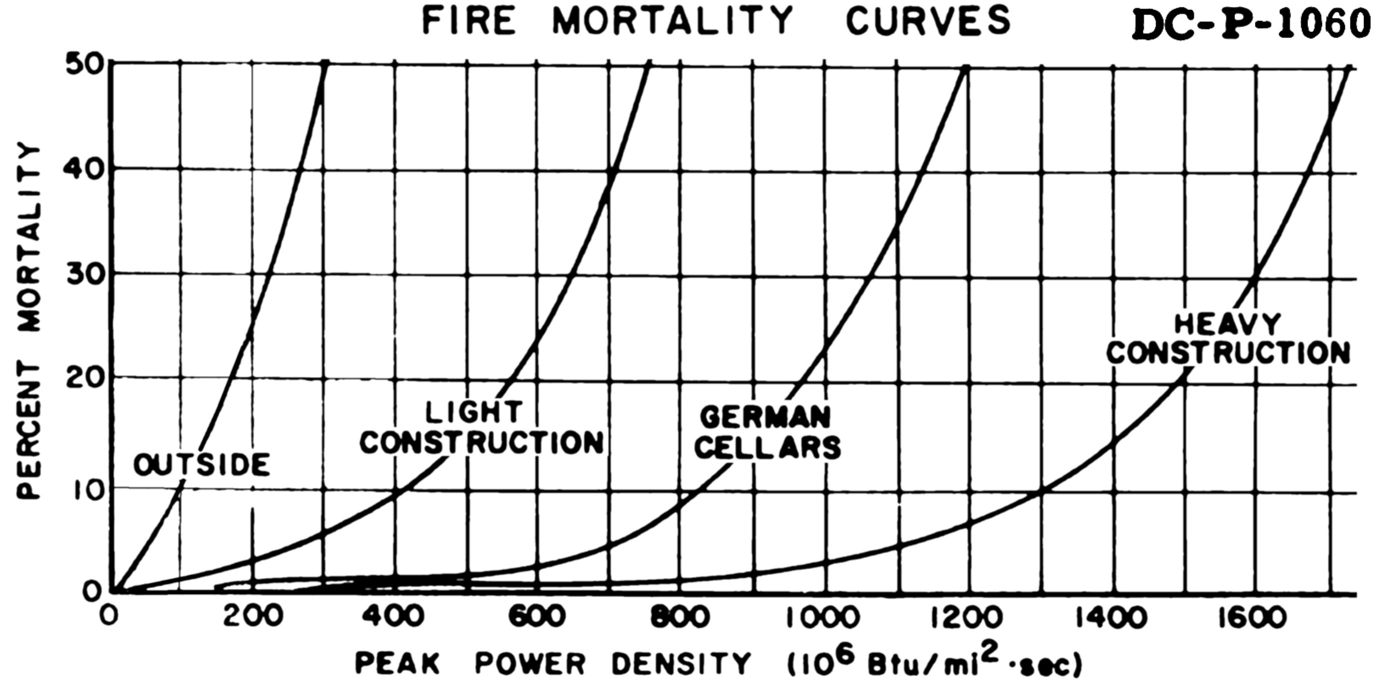

L. Wayne Davis, Donald L. Summers, William L. Baker, and James A. Keller, Prediction of Urban Casualties and the Medical Load from a High-Yield Nuclear Burst, DC-FR-1060, The Dikewood Corporation

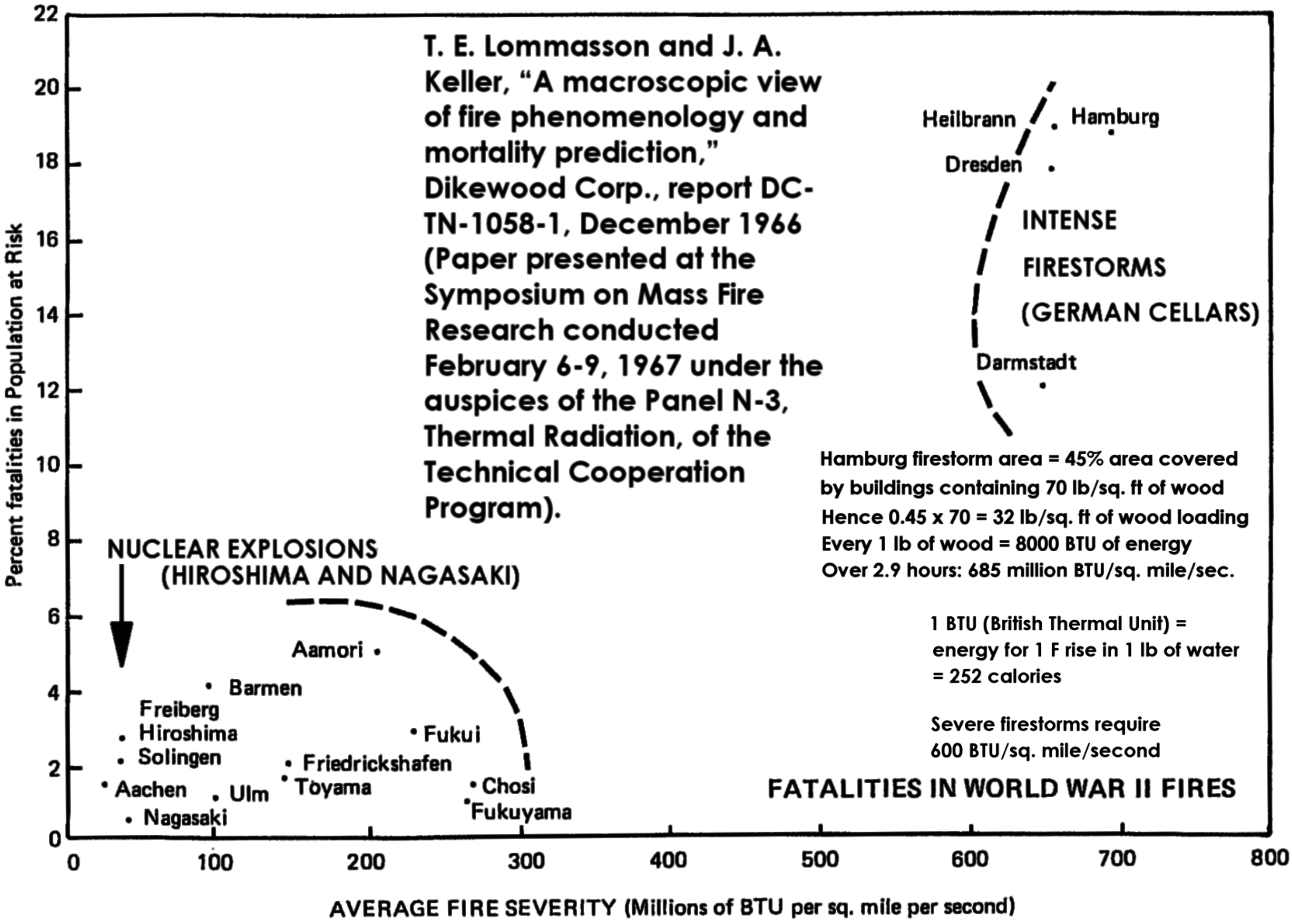



| POINT NO. | BUILDING DESIGNATION | NO. INDIVIDUALS EXPOSED |
|---|---|---|
| 1 | POST OFFICE | 400 |
| 2 | TELEGRAPH OFFICE | 301 |
| 3 | TELEPHONE OFFICE | 474 |
| 4 | CITY HALL | 216 |
| 5 | COMMUNICATIONS OFFICE | 682 |
| 6 | BRANCH POST OFFICE | 346 |
| 7 | P.O. SAVINGS OFFICE | 750 |

Ashley W. Oughterson, et al., Medical Effects of Atomic Bombs, NP-3036 to NP-3041 (Vols. I-VI), Army Institute of Pathology; 1951.

DC-P-1060

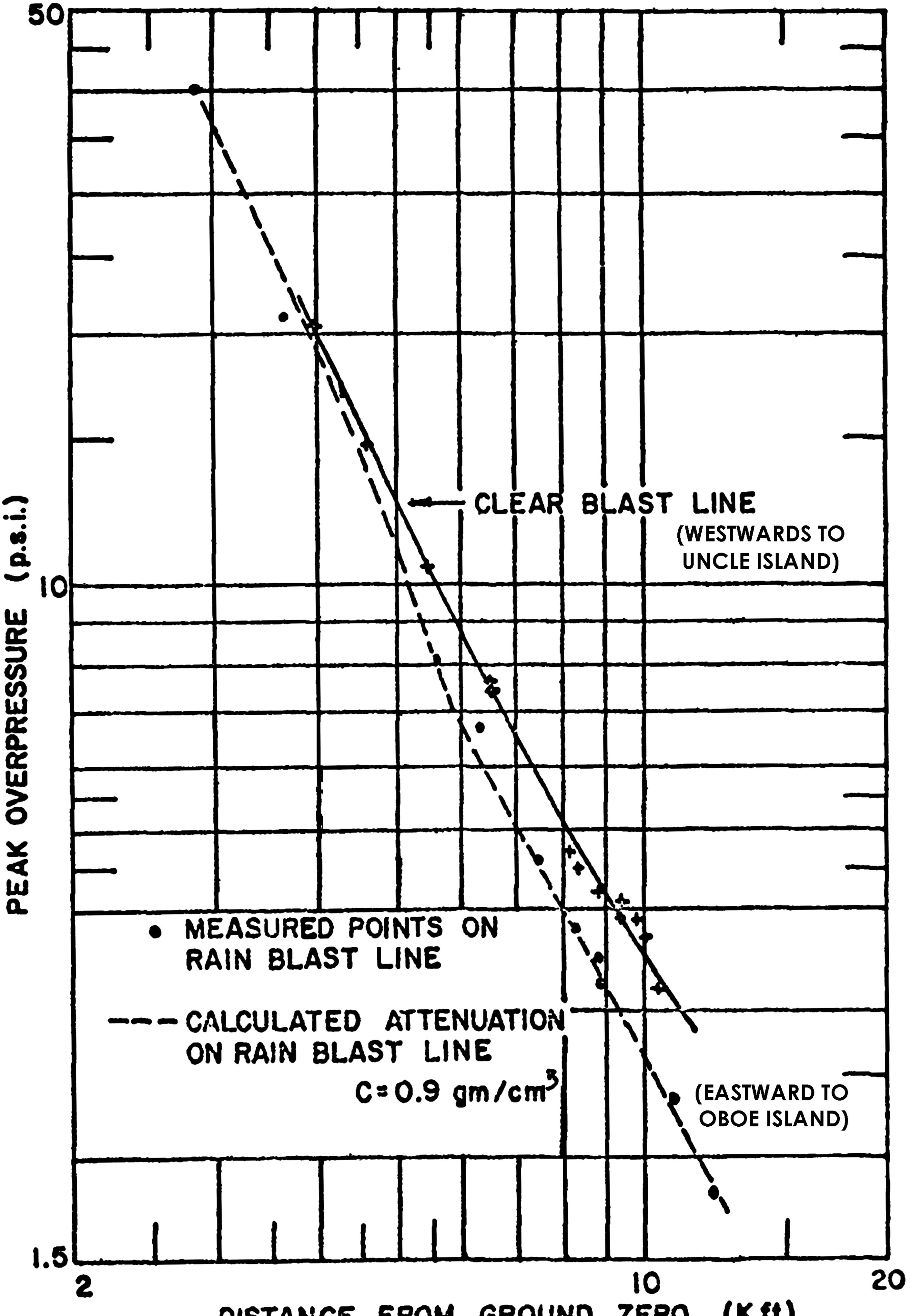



Lommasson and Keller, **A Macroscopic View of Fire Phenomenology and Mortality Predictions**, Dikewood Corporation, DC-TN-1058-1, December 1966.

J. A. Keller, A Study of World War II German Fire Fatalities, DC-TN-1050-3, The Dikewood Corporation; April, 1966.

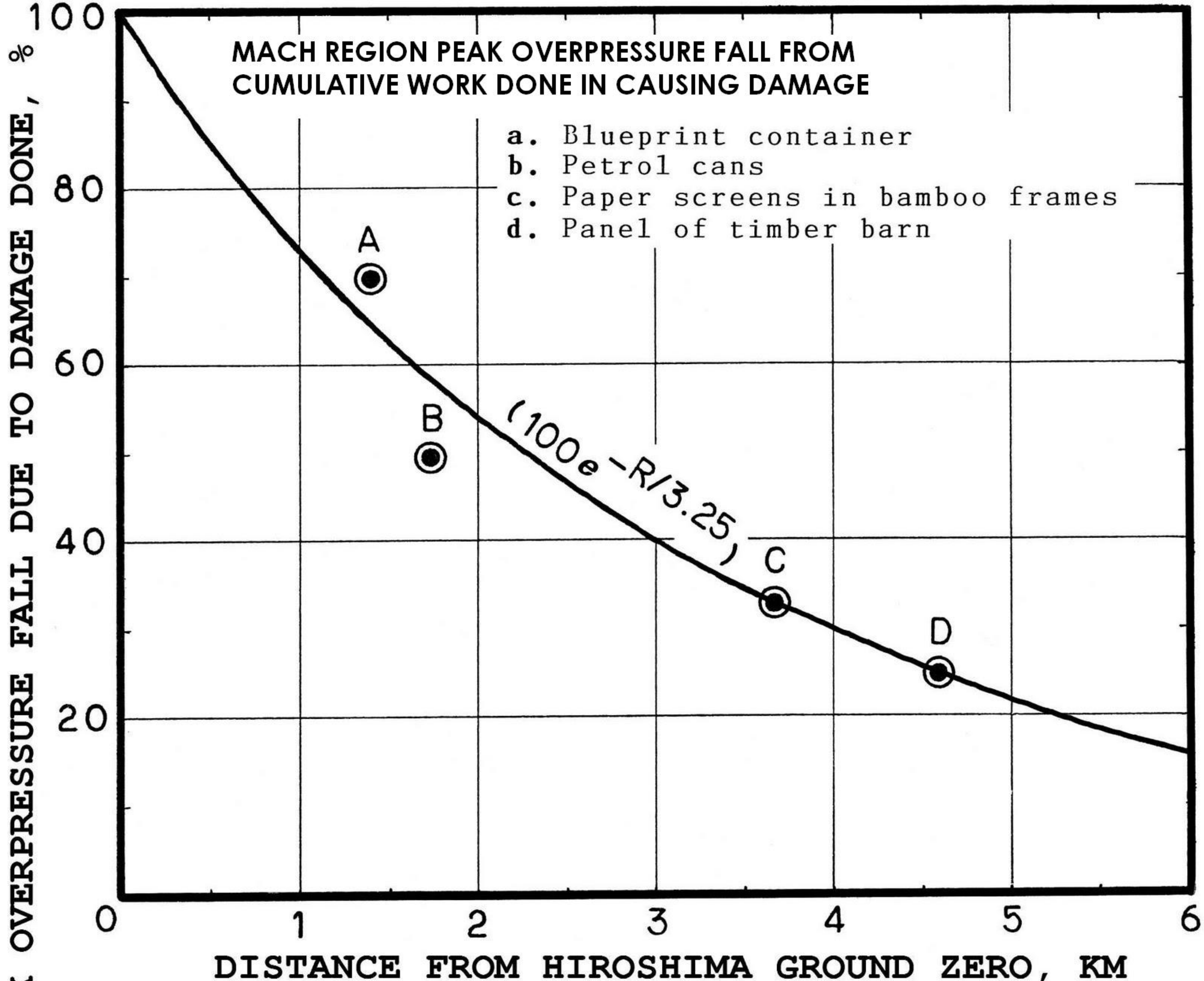
R. Schubert, Examination of Building Density and Fire Loading in the Districts Eimsbuettel and Hammerbrook of the City of Hamburg in the Year 1943 (20 volumes, in German), Stanford Research Institute; January, 1966.




WT-905: effect of rainfall

Figure 4.4 Comparison of measured and calculated attenuation of pressure, Shot 5.

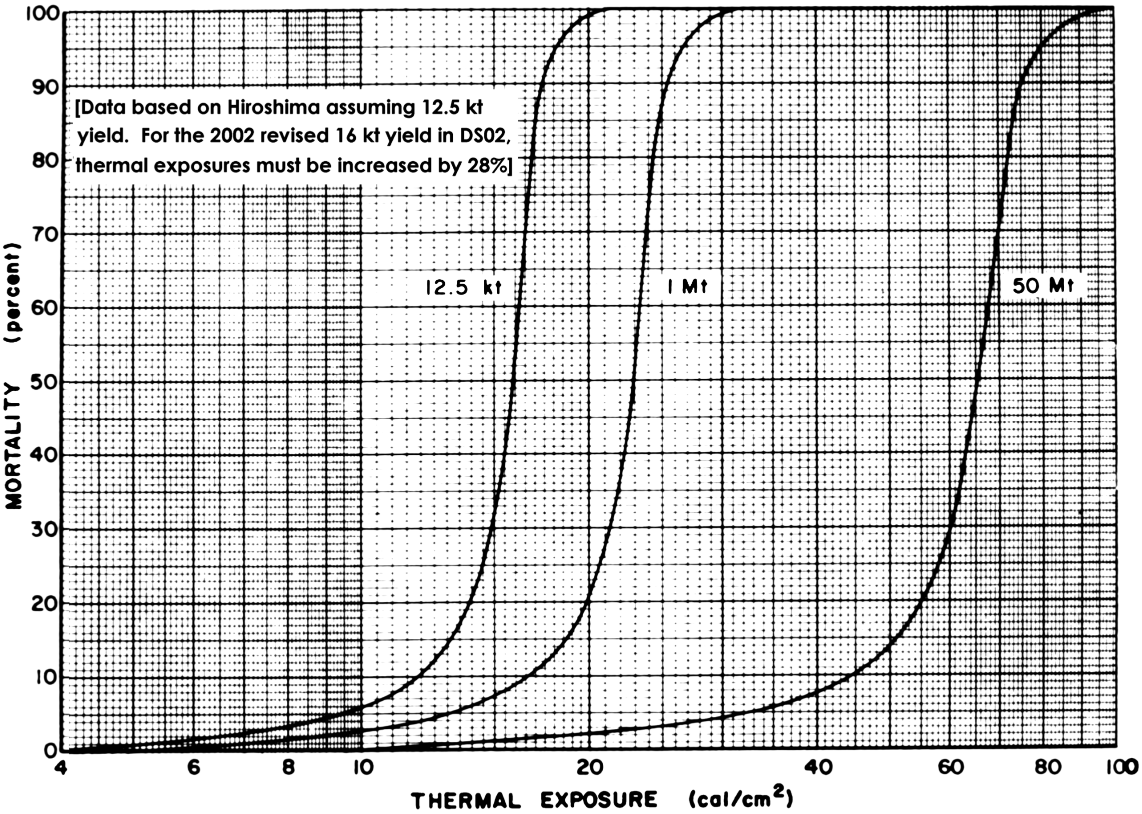
110 kt Castle Koon

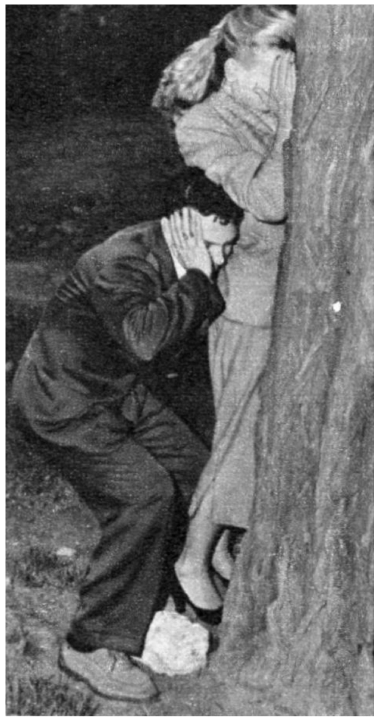



Data from Dr W. G. Penney, et al., 'The Nuclear Explosive Yields at Hiroshima and Nagasaki', Phil. Trans. Roy. Soc., v266 (1970), pp. 357-424.

L. Wayne Davis, Donald L. Summers, William L. Baker, and James A. Keller, Prediction of Urban Casualties and the Medical Load from a High-Yield Nuclear Burst, DC-FR-1060, The Dikewood Corporation

**PROMPT-THERMAL MORTALITY CURVES FROM SURFACE BURSTS FOR OUTSIDE-UNSHIELDED PERSONS**



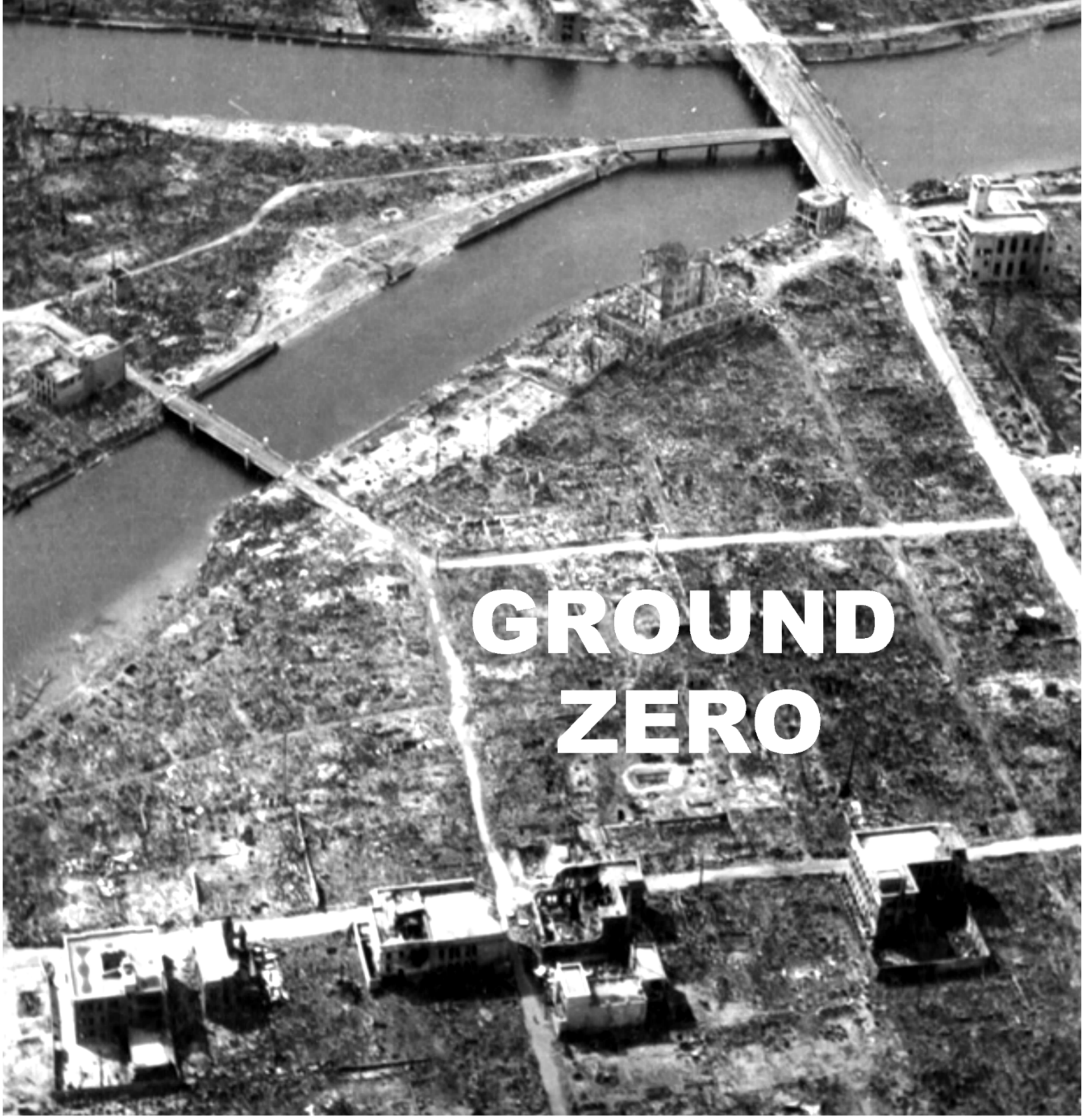
***Unless you are nude outdoors, 6.7 cal/cm$^2$ is not lethal, contrary to the OTA report!***

***Shirt protection: Nagasaki***

***Uniform protection: Hiroshima, "lethal" 6.7 cal/cm$^2$ !!!***

PROTECTION AGAINST RADIANT HEAT. *This patient (photographed by Japanese 2 October 1945) was about 6,500 feet from ground zero when the rays struck him from the left. His cap was sufficient to protect the top of his head against flash burns.*

***Above: Hiroshima soldier only burned on unclothed skin (1946 USSBS report on Hiroshima and Nagasaki, page 16)***




**Concrete bridges and buildings survive near Hiroshima's ground zero**

*NAGASAKI SHELTERS. Tunnel shelters in the hillside, such as the ones pictured (very close to ground zero), protected the few occupants from blast, heat, and radiation.*

# HOME OFFICE

CD/SA 121

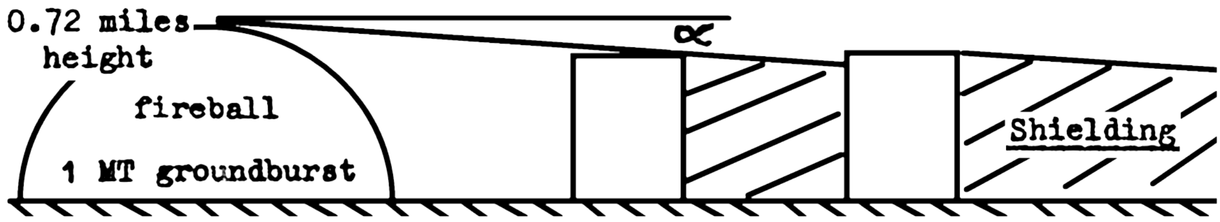
# SCIENTIFIC ADVISER'S BRANCH

## (Paper at Tripartite Thermal Effects Symposium, Dorking, October 1964)

## IGNITION AND FIRE SPREAD IN URBAN AREAS FOLLOWING A NUCLEAR ATTACK

G. R. Stanbury

### INITIAL FIRE INCIDENCE




Thermal pulse precedes the blast wave

Assuming that buildings on opposite sides of a street which is receiving heat radiation from a direction perpendicular to its length are of the same height we take the average depth of a floor to be 10 ft.

**Effect of Shielding: Estimation of the number of exposed floors**

| Distance from explosion miles | Angle of arrival $\alpha^o$ | Width of street (units of 10 ft.) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 3 | $13\frac{1}{2}$ | .5 | .5 | 1 | 1 | 1.5 | 1.5 | 2 |
| 4 | 10 | .5 | .5 | .5 | 1 | 1 | 1.5 | 1.5 |
| 5 | 8 | .5 | .5 | .5 | .5 | 1 | 1 | 1 |

### SPREAD OF FIRE

From last war experience of mass fire raids in Germany it was concluded that the overall spread factor was about 2; i.e. about twice as many buildings were destroyed by fire as were actually set alight by incendiary bombs

**Number of fires started per square mile in the fire-storm raid on Hamburg, 27th/28th July, 1943**

| 102 tons H.E. | 48 tons, 4 lb. magnesium | 40 tons, 30 lb. gel. |
|---|---|---|
| 100 fires | 27,000 bombs | 3,000 bombs |
| | 8,000 on buildings | 900 on buildings |
| | 1,600 fires | 800 fires |
| | 2,500 fires in 6,000 buildings | |

However, the important thing to note is that the total number of fires started in each square mile (2,500) was nearly half that of the total number of buildings; in other words, almost every other building was set on fire

When the figure of 1 in 2 for the German fire storms is compared with the figures for initial fire incidence of $\sim$ 1 in 15 to 30 obtained in the Birmingham and Liverpool studies it can only be concluded that a nuclear explosion could not possibly produce a fire storm.

# SECONDARY FIRES FROM BLAST DAMAGE IN LONDON

**Fire situation from 1,499 fly bombs in the built-up part of the London Region**

(Fires from 1 ton TNT V1 cruise missiles, 1944)

| | Number of fly bombs | Fly Bombs Caused | | | | |
|---|---|---|---|---|---|---|
| | | No fire | Small fire | Medium fire | Serious fire | Major fire |
| Grand Totals | 1,499 | 804 | 609 | 75 | 7 | 4 |

The large proportion started no fires at all even in the most heavily built-up areas.

All these fly bombs fell in the summer months of 1944 which were unusually dry. In winter in this country in residential areas there are many open fires which may provide extra sources of ignition. The domestic occupancy is a low fire risk however, and as the proportion of such property in the important City and West End areas is small this should not introduce any serious error. Moreover, in winter, the high atmospheric humidity and the correspondingly high moisture content of timber would tend to retard or even prevent the growth of fire.

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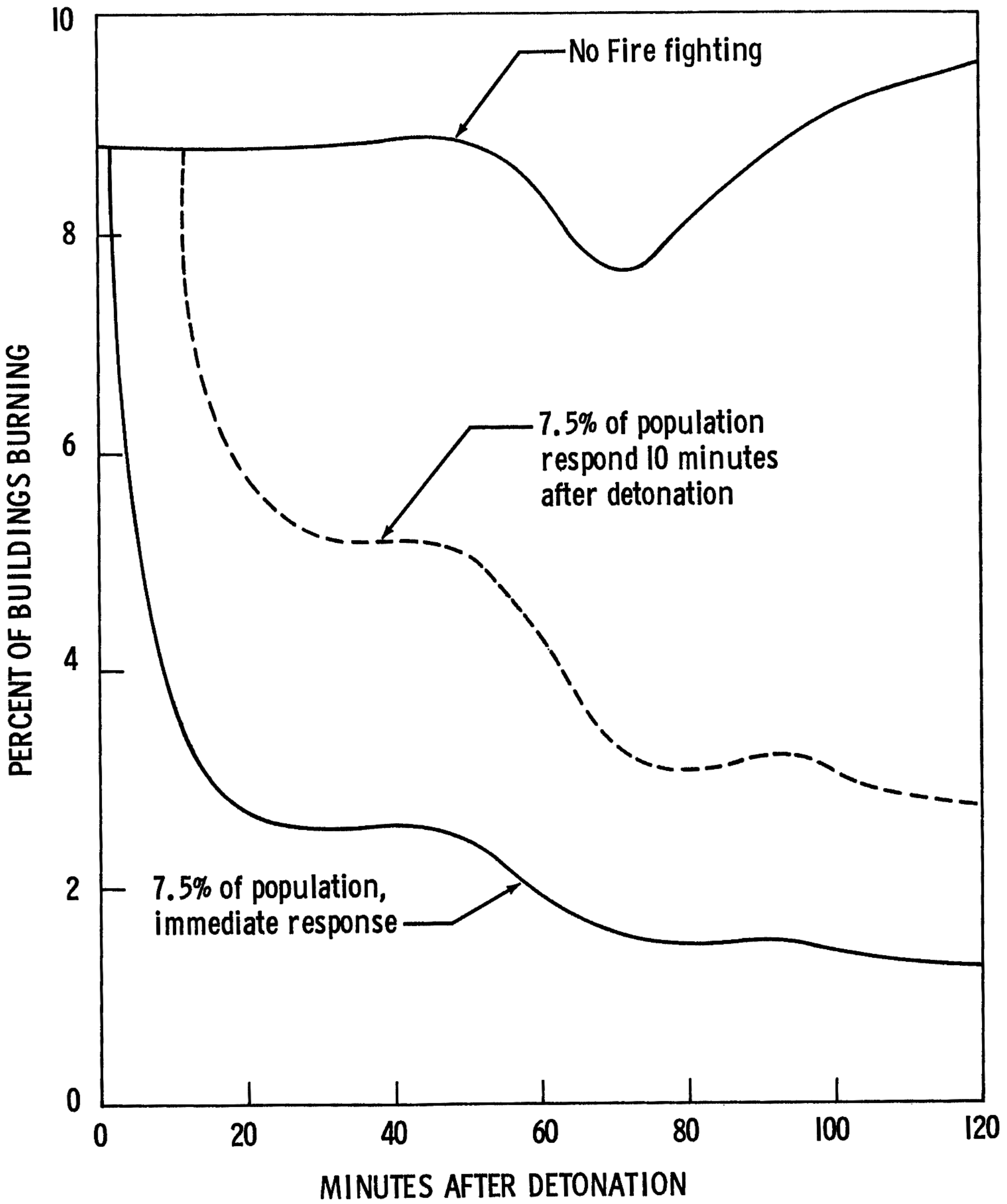
**Takata, A.N., Mathematical Modeling of Fire Defenses, IITRI, March 1970, AD 705 388.**



OFFICE OF THE AIR SURGEON

NP-3041

# MEDICAL EFFECTS OF ATOMIC BOMBS

## The Report of the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan; Volume VI

By
Ashley W. Oughterson
George V. LeRoy
Averill A. Liebow
E. Cuyler Hammond
Henry L. Barnett
Jack D. Rosenbaum
B. Aubrey Schneider

July 6, 1951
[TIS Issuance Date]

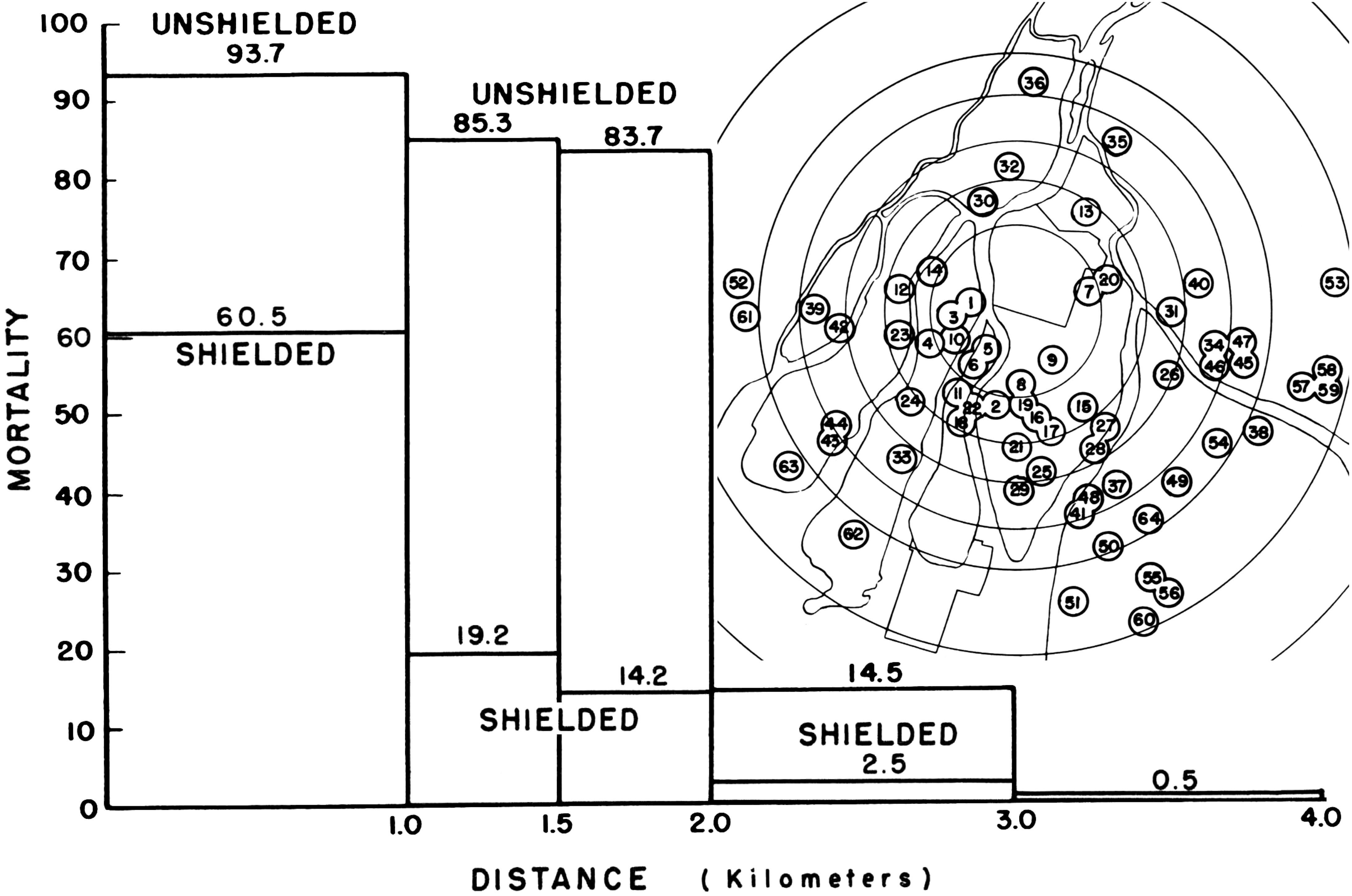
Army Institute of Pathology

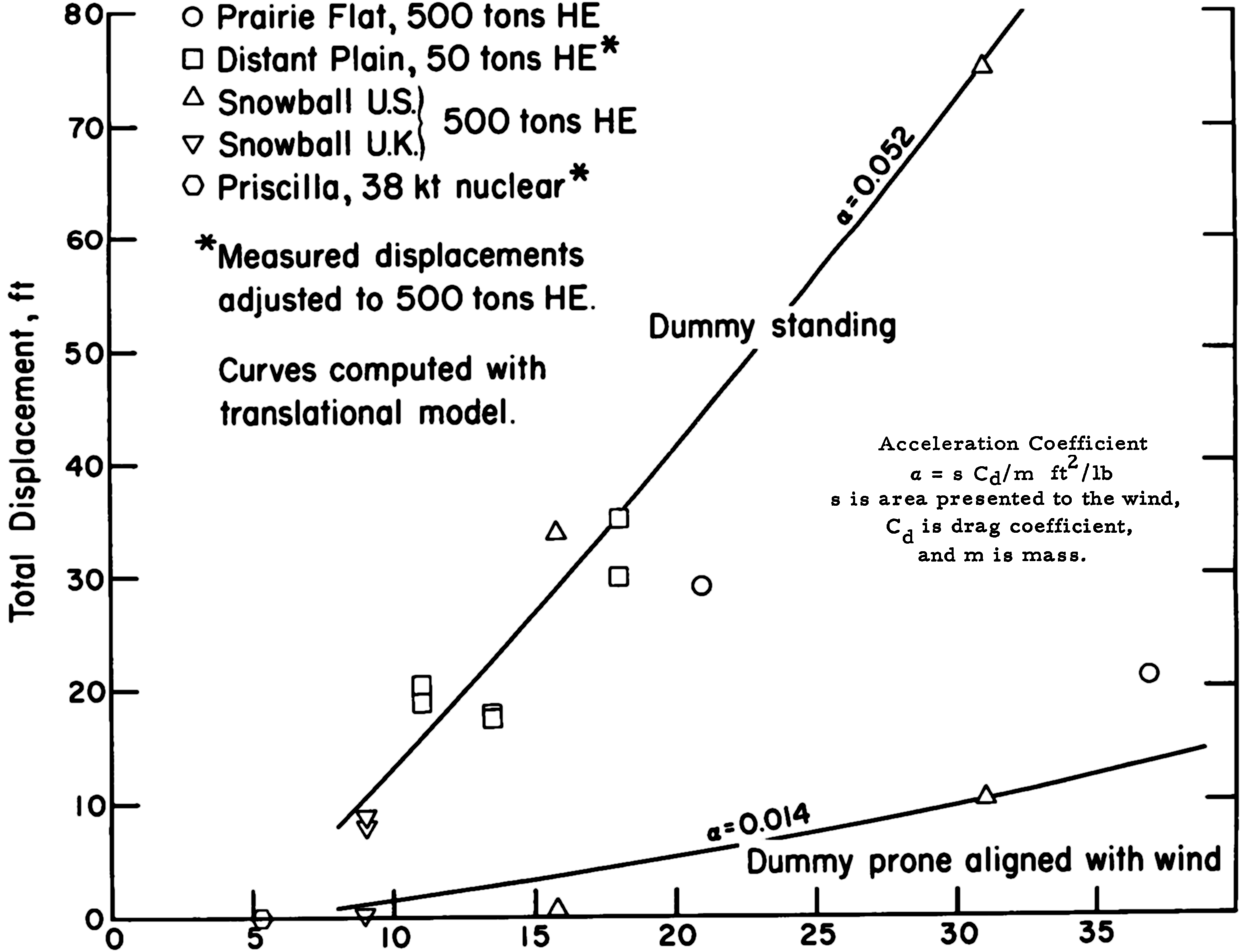
UNITED STATES ATOMIC ENERGY COMMISSION
Technical Information Service, Oak Ridge, Tennessee

NP-3041

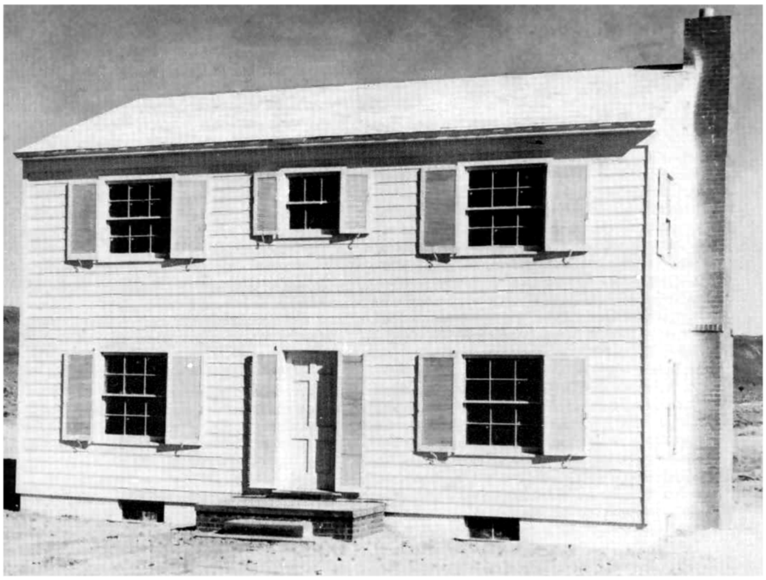
# HIROSHIMA SCHOOL CHILDREN

# WORK PARTIES DISTRIBUTION




○ Prairie Flat, 500 tons HE
□ Distant Plain, 50 tons HE*
△ Snowball U.S.
▽ Snowball U.K.
500 tons HE
⬡ Priscilla, 38 kt nuclear*
*Measured displacements adjusted to 500 tons HE.
Curves computed with translational model.
α=0.052
Dummy standing
Acceleration Coefficient
α = s Cd/m ft²/lb
s is area presented to the wind,
Cd is drag coefficient,
and m is mass.
α=0.014
Dummy prone aligned with wind
Total Displacement, ft
Peak Overpressure, psi
0
10
20
30
40
50
60
70
80
5
15
25
35

DASA 2710

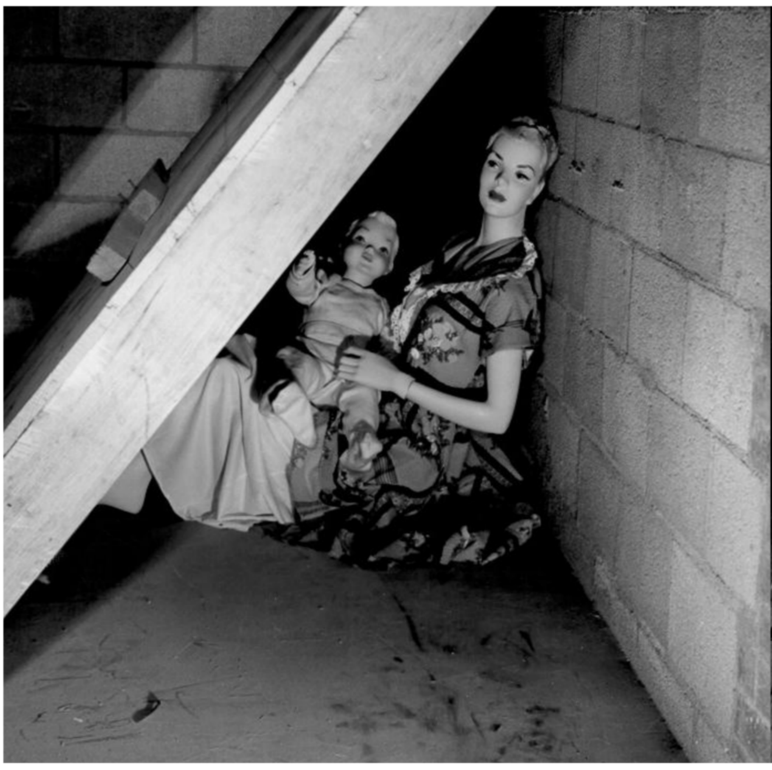


**1 HB–8**
*The house at Main and Elm Streets. Two typical colonial two-story center hall frame dwellings were placed at 3,500 and 7,500 feet from the bomb tower. (FCDA—Operation Doorstep—Yucca Flat, Nev., Mar. 17, 1953.)*

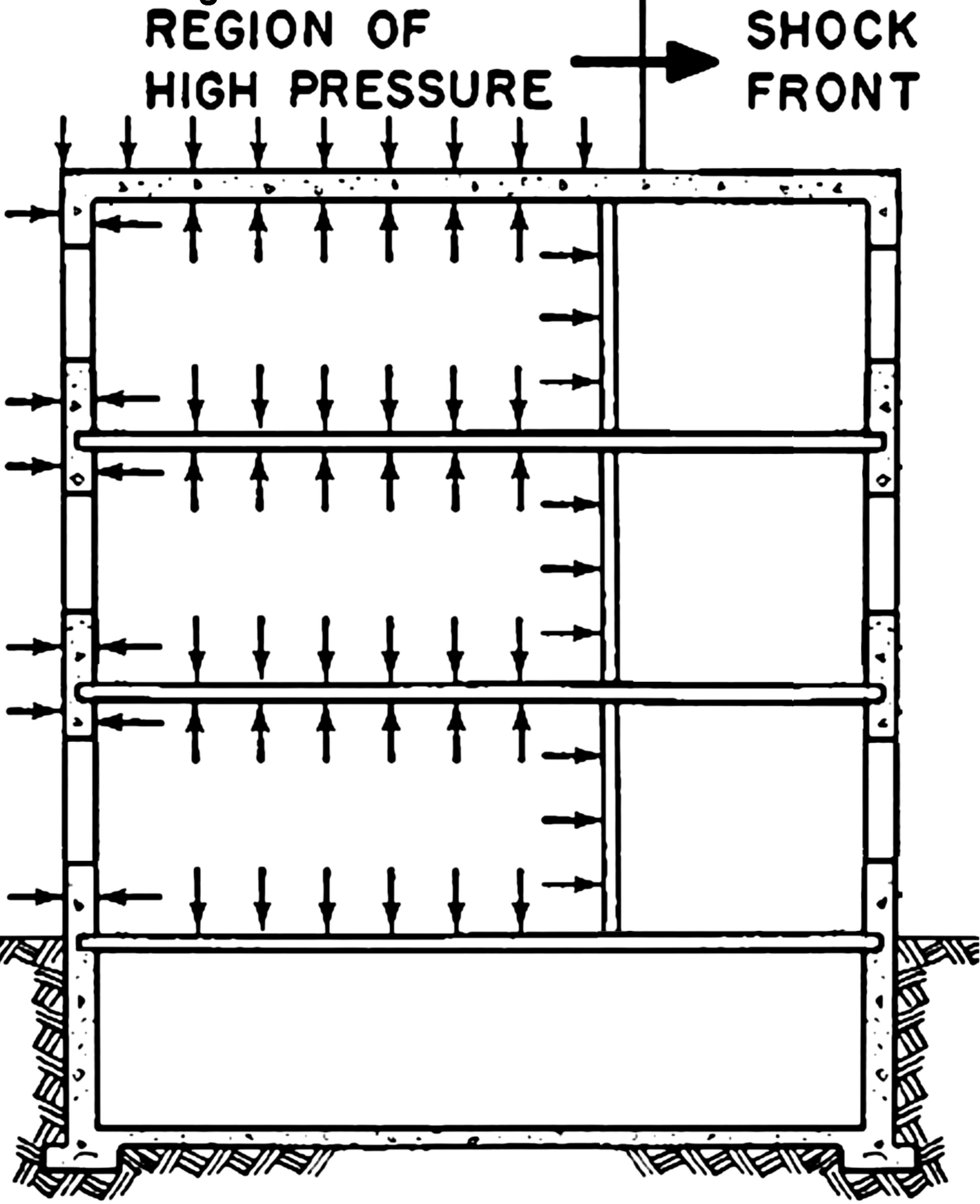
**X–19**
*This mannequin can only stay in the position in which he was placed, staring through the window at coming disaster. A real occupant of this house could prepare—and survive. (FCDA—Operation Doorstep—Yucca Flat, Nev., Mar. 17, 1953.)*

**1 HA–11**
*House No. 1, from the camera tower from which the dramatic collapse pictures were taken. The Post Office truck to the left, although it lost all windows and suffered body damage, was driven away later, as was the car in the rear of the house. Entry to the basement was made through the corner at lower center. (FCDA—Operation Doorstep—Yucca Flat, Nev., Mar. 17, 1953.)*

**LSA–2**
*3,500 feet from ground zero. The house overhead is totally destroyed, some of it has fallen into the basement, but the mannequin in the lean-to shelter is undisturbed. The photo was taken from ground level, looking into the basement through the gap between the basement wall and the broken floor timbers. (FCDA—Operation Doorstep—Yucca Flat, Nev., Mar. 17, 1953.)*



Rapid equalization of inside and outside pressure for large window areas



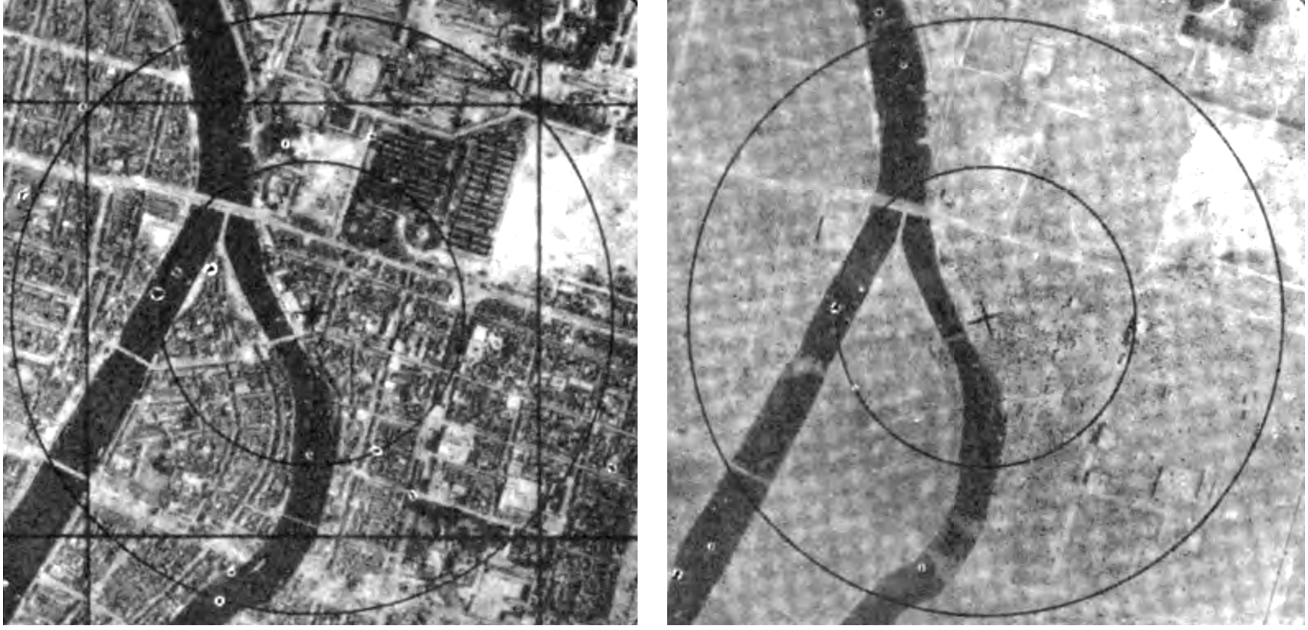
# THE UNITED STATES STRATEGIC BOMBING SURVEY

## The Effects of Atomic Bombs on Hiroshima and Nagasaki

CHAIRMAN'S OFFICE

30 June 1946

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1946



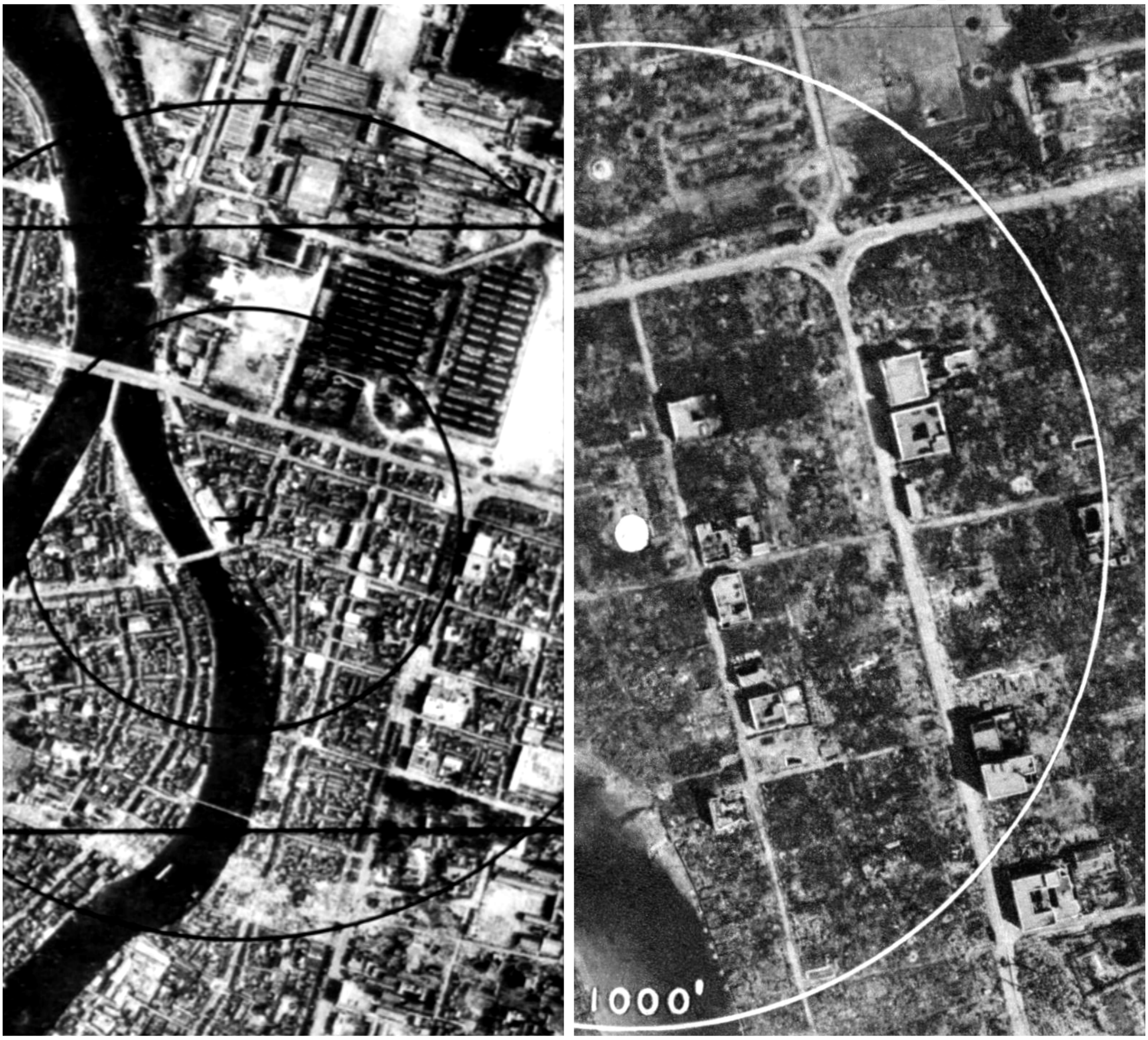
***HIROSHIMA before and after bombing. Area around ground zero. 1,000 foot circles.***

**A. A. F. Photos**

**7**

**Above: surviving buildings are air-brushed out of photo of Hiroshima 1946 USSBS openly published Hiroshima and Nagasaki report, page 7**

Below: secret BEFORE and AFTER Hiroshima photos




**Hiroshima BEFORE (USSBS photo)** **Modern concrete buildings AFTER.**

**Small wooden, overcrowded houses have burned down after blast overturned stoves (8:15 am, breakfast time).**

# II. THE EFFECTS OF THE ATOMIC BOMBINGS

## A. THE ATTACKS AND DAMAGE

1. *The attacks.*—A single atomic bomb, the first weapon of its type ever used against a target, exploded over the city of Hiroshima at 0815 on the morning of 6 August 1945. Most of the industrial workers had already reported to work, but many workers were enroute and nearly all the school children and some industrial employees were at work in the open on the program of building removal to provide firebreaks and disperse valuables to the country. The attack came 45 minutes after the "all clear" had been sounded from a previous alert. Because of the lack of warning and the populace's indifference to small groups of planes, the explosion came as an almost complete surprise, and the people had not taken shelter. Many were caught in the open, and most of the rest in flimsily constructed homes or commercial establishments.

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At Nagasaki, 3 days later, the city was scarcely more prepared, though vague references to the Hiroshima disaster had appeared in the newspaper of 8 August. From the Nagasaki Prefectural Report on the bombing, something of the shock of the explosion can be inferred:

> The day was clear with not very much wind—an ordinary midsummer's day. The strain of continuous air attack on the city's population and the severity of the summer had vitiated enthusiastic air raid precautions. Previously, a general alert had been sounded at 0748, with a raid alert at 0750; this was canceled at 0830, and the alertness of the people was dissipated by a great feeling of relief.

The city remained on the warning alert, but when two B–29's were again sighted coming in the raid signal was not given immediately; the bomb was dropped at 1102 and the raid signal was given a few minutes later, at 1109. Thus only about 400 people were in the city's tunnel shelters, which were adequate for about 30 percent of the population.



2. *Hiroshima.*

If there were, as seems probable, about 245,000 people in the city at the time of the attack, the density in the congested area must have been about 35,000 per square mile. Five completed evacuation programs and a sixth then in progress had reduced the population from its wartime peak of 380,000.

In Hiroshima (and in Nagasaki also) the dwellings were of wood construction; about one-half were one story and the remainder either one and one-half or two stories. The roof coverings were mostly hard-burnt black tile. There were no masonry division walls, and large groups of dwellings clustered together. The type of construction, coupled with antiquated fire-fighting equipment and inadequately trained personnel, afforded even in peacetime a high possibility of conflagration. Many wood-framed industrial buildings were of poor construction by American standards. The principal points of weakness were the extremely small tenons, the inadequate tension joints, and the inadequate or poorly designed lateral bracings. Reinforced concrete framed buildings showed a striking lack of uniformity in design and in quality of materials. Some of the construction details (reinforcing rod splices, for example) were often poor, and much of the concrete was definitely weak; thus some reinforced concrete buildings collapsed and suffered structural damage when within 2,000 feet of ground zero, and some internal wall paneling was demolished even up to 3,800 feet. (For convenience, the term "ground zero" will be used to designate the point on the ground directly beneath the point of detonation, or "air zero.")



Hiroshima's industrial production could have resumed normal operation within 30 days of the attack had the war continued.

official Japanese figures summed up the building destruction at 62,000 out of a total of 90,000 buildings in the urban area, or 69 percent. An additional 6,000 or 6.6 percent were severely damaged, and most of the others showed glass breakage or disturbance of roof tile. These figures show the magnitude of the problem facing the survivors.

Despite the absence of sanitation measures, no epidemics are reported to have broken out.

9

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Nagasaki

Because parts of the city were protected by hills, more than one-half of the residential units escaped serious damage. Of the 52,000 residential units in the city on 1 August, 14,146 or 27.2 percent were completely destroyed (by Japanese count) (11,494 of these were burned); 5,441 or 10.5 percent were half-burned or destroyed; many of the remaining units suffered superficial or minor damage.

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Because of the brief duration of the flash wave and the shielding effects of almost any objects—leaves and clothing as well as buildings—there were many interesting cases of protection. The radiant heat came in a direct line like light, so that the area burned corresponded to this directed exposure. Persons whose sides were toward the explosion often showed definite burns of both sides of the back while the hollow of the back escaped. People in buildings or houses were apparently burned only if directly exposed through the windows. The most striking instance was that of a man writing before a window. His hands were seriously burned but his exposed face and neck suffered only slight burns due to the angle of entry of the radiant heat through the window.

Flash burns were largely confined to exposed areas of the body, but on occasion would occur through varying thicknesses of clothing. Generally speaking, the thicker the clothing the more likely it was to give complete protection against flash burns.

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A large percentage of the cases died of secondary disease, such as septic bronchopneumonia or tuberculosis, as a result of lowered resistance. Deaths from radiation began about a week after exposure and reached a peak in 3 to 4 weeks. They had practically ceased to occur after 7 to 8 weeks.

19

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The flash heat was intense enough to cause fires, despite the distance of the fireball from the ground. Clothing ignited, though it could be quickly beaten out, telephone poles charred, thatched roofs of houses caught fire. In Hiroshima, the explosion started hundreds of fires almost simultaneously, the most distant of which was found 13,700 feet from ground zero; this, however, probably started when a building with a thatched roof collapsed onto a hot charcoal fire. Fires were started directly by flash heat in such easily ignitible substances as dark cloth, paper, or dry-rotted wood, within about 3,500 feet of ground zero; white-painted, concrete-faced or cement-stuccoed structures reflected the heat and did not ignite. A cedar bark roof and the top of a dry-rotted wooden platform 5,200 feet west of ground zero, were reported to have been ignited by the bomb flash. The majority of initial fires in buildings, however, were started by secondary sources (kitchen charcoal fires, electric short-circuits, industrial process fires, etc.).

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Serious or third-degree burns were suffered by those directly exposed within 4,500 feet, and occasionally as remote as 7,200 feet. In the immediate area of ground zero, the heat charred corpses beyond recognition.

Clothing as well as buildings afforded considerable protection against the flash. Even a clump of grass or tree leaf was, on occasion, adequate.

The implication clearly is that the duration of the flash was less than the time required for the grass or leaf to shrivel. While an accurate estimate is not possible, the duration could hardly have exceeded a fraction of a second.

25

*NEW SHOOTS are appearing on this limb of a chestnut tree, about 2,100 feet south of ground zero at Nagasaki, 2 months after the attack, even though the leaves were burned and withered at the time of the explosion (Japanese photo).*

## B. WHAT WE CAN DO ABOUT IT

The danger is real—of that, the Survey's findings leave no doubt. Scattered through those findings, at the same time, are the clues to the measures that can be taken to cut down potential losses of lives and property.

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1. *Shelters.*—The most instructive fact at Nagasaki was the survival, even when near ground zero, of the few hundred people who were properly placed in the tunnel shelters. Carefully built shelters, though unoccupied, stood up well in both cities. Without question, shelters can protect those who get to them against anything but a direct hit. Adequate warning will assure that a maximum number get to shelters.

Analysis of the protection of survivors within a few hundred feet of ground zero shows that shielding is possible even against gamma rays. At Hiroshima, for example, persons in a concrete building 3,600 feet from ground zero showed no clinical effects from gamma radiation, but those protected only by wooden buildings at a similar distance suffered from radiation disease. The necessary thickness varies with the substance and with the distance from the point of detonation. Adequate shelters can be built which will reduce substantially the casualties from radiation.

Men arriving at Hiroshima and Nagasaki have been constantly impressed by the shells of reinforced concrete buildings still rising above the rubble of brick and stone or the ashes of wooden buildings. In most cases gutted by fire or stripped of partitions and interior trim, these buildings have a double lesson for us. They show, first, that it is possible without excessive expense to erect buildings which will satisfactorily protect their contents at distances of about 2,000 feet or more from a bomb of the types so far employed. Construction of such buildings would be similar to earthquake resistant construction, which California experience indicates would cost about 10 percent to 15 percent more than conventional construction. Even against more powerful bombs or against near misses, such construction would diminish damage.



As defensive weapons, atomic bombs are useful primarily as warnings, as threats of retaliation which will restrain a potential aggressor from their use as from the use of poison gas or biological warfare. The mission of active defense, as of passive defense, is thus to prevent the surprise use of the atomic bomb from being decisive. A wise military establishment will make sure—by dispersal, concealment, protection, and constant readiness of its forces—that no single blow or series of blows from an enemy can cripple its ability to strike back in the same way or to repel accompanying attacks from other air, ground, or sea forces. The measures to enable this unrelaxing state of readiness are not new; only their urgency is increased. Particularly is this true of the intelligence activities on which informed decisions and timely actions depend.

The need for research is not limited to atomic energy itself, but is equally important in propellants, detection devices, and other techniques of countering and of delivering atomic weapons.

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5. *Conclusion.*—One further measure of safety must accompany the others. To avoid destruction, the surest way is to avoid war. This was the Survey's recommendation after viewing the rubble of German cities, and it holds equally true whether one remembers the ashes of Hiroshima or considers the vulnerability of American cities.

Our national policy has consistently had as one of its basic principles the maintenance of peace. Based on our ideals of justice and of peaceful development of our resources, this disinterested policy has been reinforced by our clear lack of anything to gain from war—even in victory. No more forceful arguments for peace and for the international machinery of peace than the sight of the devastation of Hiroshima and Nagasaki have ever been devised. As the developer and exploiter of this ominous weapon, our nation has a responsibility, which no American should shirk, to lead in establishing and implementing the international guarantees and controls which will prevent its future use.

# Mechanix Illustrated, Jan. 1951

Head for the basement as soon as the siren sounds and remain as close as possible to heavy, supporting columns to avoid the danger of collapsing beams. Stay away from all entrances and all windows. If there are heavy steel doors and shutters, close them.

The British government recommends construction of raid shelters on the order of the Anderson-type, built outside many British homes during the Hitler blitz. These were steel arches, six feet high and four-and-a-half feet wide, half buried in the ground. Civil defense authorities assert that if three feet of earth were piled above the arch, the shelter could protect all inside from the four main causes of death and injury.

Don't be in a rush to emerge from your hideout—stay there until you have been assured the bomb will not be dropped, long enough for radiation outside to wear off.

IF YOU ARE TRAPPED ON THE TOP FLOOR OF A BUILDING . . .
and descent to the basement is prevented by jammed elevators and stairs, don't join the mob battling to get down. Proceed to a point as close to the center of the building as possible and lie against a wall or strong supporting column, out of line of the windows. Or crawl under a table, sofa or desk which would provide protection against flying glass.

IF YOU ARE WALKING ON THE STREET . . .
get out of the open. Remember that flash and flame burns killed 50 per cent of the 106,000 persons who died in the atomic attack on Hiroshima and Nagasaki and accounted for 75 per cent of all casualties. The bomb's heat rays travel in a straight line—so all you have to do is get inside.

Head for the nearest official shelter. If there aren't any, a subway—the deeper the better—will do as well.

**Target area at Hiroshima was completely leveled except for a few reinforced concrete building frames. That's why American builders of A-bomb shelters concentrate on the use of thick concrete walls.**

The U. S. Strategic Bombing Survey No. 5 undertaken by the U. S. Air Force, states flatly: "The most instructive fact at Nagasaki was the survival of the few hundred people who were properly placed in tunnel shelters. Without question, shelters can protect those who get to them against anything but a direct hit."

The best protection from shock, radiation and heat is reinforced concrete; almost as good is closely packed earth. The thickness required to protect you fully depends, obviously, on the distance from the blast. How much protection and at what distances? Well many other factors influence the effect of an atomic blast, including height of the burst, direction of the blast and types of buildings in its path. The government handbook, The Effects of Atomic Weapons, estimates that at a half-mile from the explosion, a 12-inch reinforced concrete wall inside a building would provide enough protection.

# INDUSTRIAL PREPAREDNESS AND NUCLEAR WAR SURVIVAL

**WEDNESDAY, NOVEMBER 17, 1976**

U.S. CONGRESS,
JOINT COMMITTEE ON DEFENSE PRODUCTION,
*Washington, D.C.*

MR. THOMAS K. JONES

Mr. Jones is the Program and Product Evaluation Manager for the Boeing Aerospace Company. In this capacity he directs analyses and studies of national requirements, evaluates the capabilities of present and potential product lines to satisfy national requirements, and determines the allocation of research budgets to product programs.

From June 1971 thru August 1974, Mr. Jones was employed by the Office of the Secretary of Defense (DDR&E) in support of the Strategic Arms Limitations Talks (SALT). In this assignment, he served as Deputy Director, OSD SALT support group and as Senior Adviser to the OSD member of the U.S. SALT delegation. Through his appointment as a consultant to the Defense Science Board, he is continuing to support the SALT activities.

From 1954 until his employment by the Department of Defense, Mr. Jones was employed by Boeing in a number of design engineering, system engineering, and management assignments. These assignments included work on options to extend the viability of the Minuteman ICBM system, study of strategic tanker systems, analysis of ABM systems, system engineering of manned space systems, and design of strategic bomber systems.

## STATEMENT OF MR. THOMAS K. JONES, PROGRAM AND PRODUCT EVALUATION MANAGER, BOEING AEROSPACE COMPANY, ACCOMPANIED BY MR. JOHN R. POTTER, DIRECTOR OF FACILITIES, BOEING COMMERCIAL AIRPLANE COMPANY; AND MR. EDWIN N. YORK, NUCLEAR EFFECTS SPECIALIST

Evacuation, because it distributes people over a comparatively large area, allow them to survive. The United States could, by foregoing half the effectiveness of its arsenal against industrial facilities, spread a lethal level of radioactive fallout over 15 percent of the Soviet Union. However, the evacuees will dig simple shelters to protect against this possibility. The decay rate of that radiation intensity would, within a week, permit the Russians to be out of their shelters for at least an 8-hour workday in 97 percent of their territory.

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The Soviet civil defense manuals also provide for a number of ways to protect the critical production machinery within the factories. A book written by A. A. Gromov, hero of Socialist labor and director of the First State Ball Bearing Plant, outlines how these protective methods are being applied to his factory.

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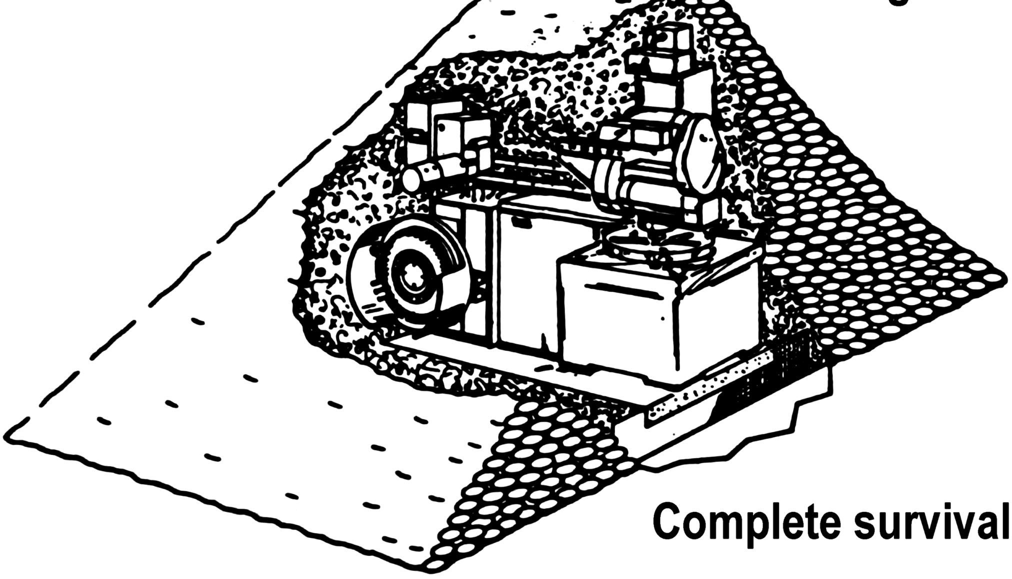
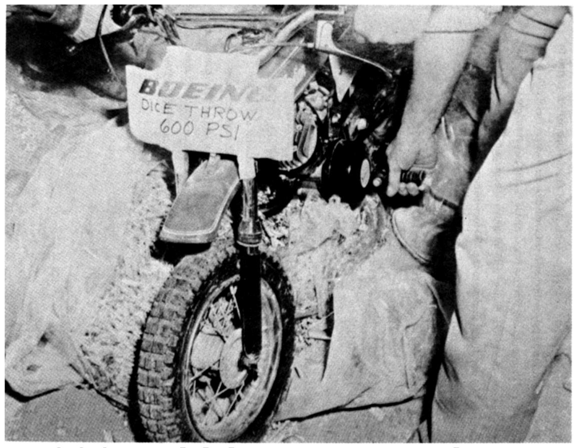
A gas-powered minibike was successfully protected against a blast pressure of 600 pounds per square inch, and a soil heave of 1½ feet; after the test, it was dug out, started and driven away.

In brief, the results of this test indicate that industrial machines, if properly protected, can survive within a few hundred feet from a 40 kiloton nuclear blast, or 2,000 feet from a 1 megaton.

These protective measures, if applied to the Seattle-Tacoma-Everett metropolitan area, could permit resumption of some production operations as early as 4 to 12 weeks after a nuclear attack, depending on the level of radiation intensity.

**Protected 5-axis mill** **Boeing test**






**Complete survival**

**600 psi blast protection for a minibike at .5 kt TNT "Dice Throw" 6 Oct 1976**

Dirt filled bags protecting USSR machinery from nuclear war

*Civil Defense of an Industrial Installation*, A. A. Gromov

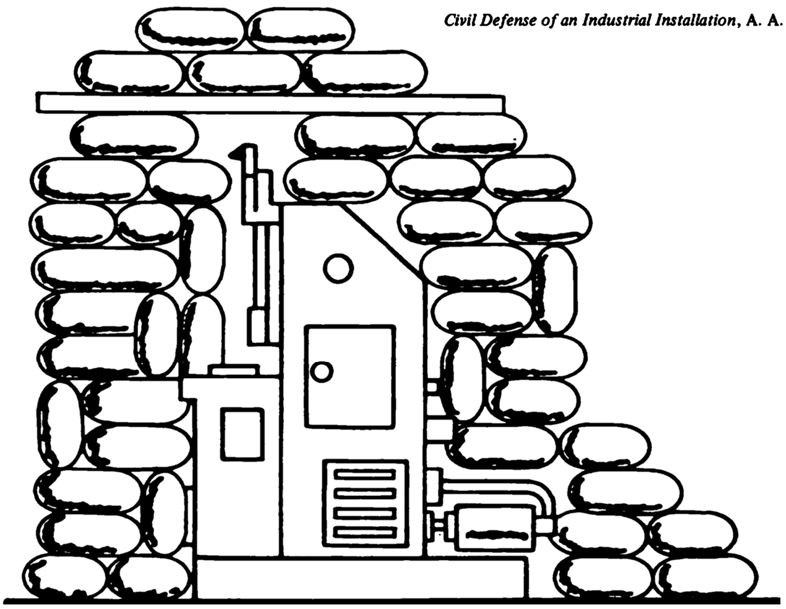


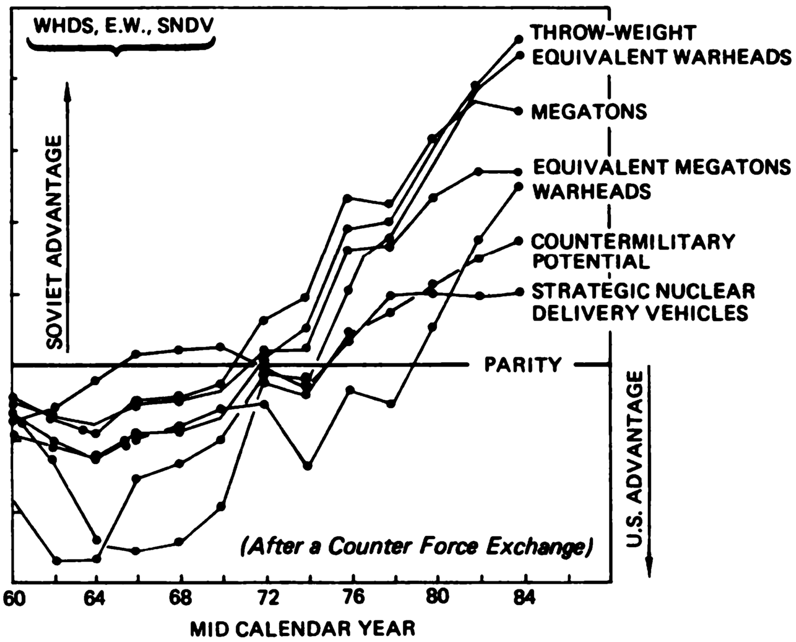
*Рис. 2. Вариант консервации*

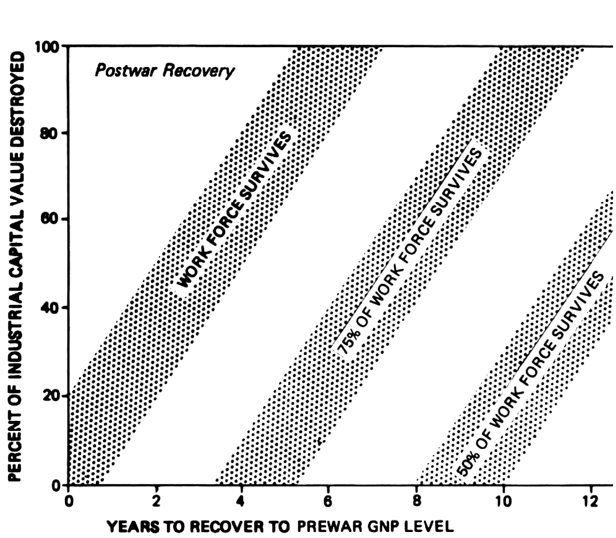
*Расход материалов: мешки — 180; брус 60×200 — 20 пог. м; пленка полиэтиленовая — 25 м².*

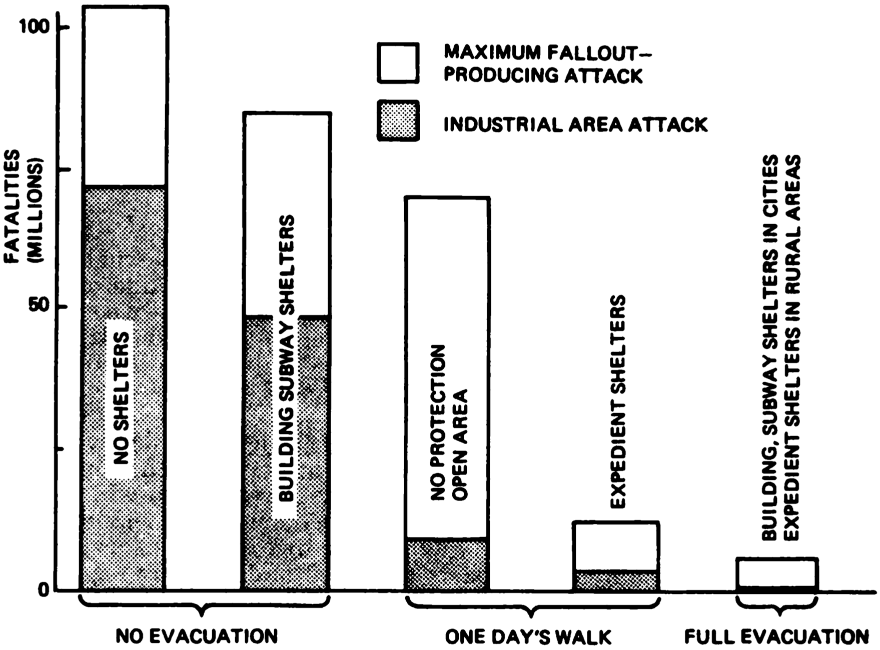
*Затрата рабочей силы: насыпка мешков песком, подноска, укладка — 58 чел/час; бригадой в 8 человек при 10-часовой смене работа выполняется за 5,3 часа*

D180-20236-1

*Figure A-3. Comparison of Alternative Indices of Capability*




Soviet population fatalities (surviving U.S. Strategic Forces).

After World War II, public attention was focused almost exclusively on the awesome destructive power of nuclear weapons. As a result, the industrial recovery of bombed cities such as Hiroshima went unnoticed. However, the fact that industry can and will recover from even nuclear devastation is evident from the published findings of the U.S. Strategic Bombing Survey of Hiroshima. The day after the explosion, bridges into downtown Hiroshima were open to traffic, and electric service was restored in some areas. On the second day, trains were again operating. By the third day, some streetcar lines resumed service. Within 9 days, telephone service was restored to the city center. In the outlying areas of the city, water, sewer, and gas services were never interrupted. When the U.S. survey team arrived 2 months after the explosion, the survivors were starting to erect dwellings on their original homesites.[5]

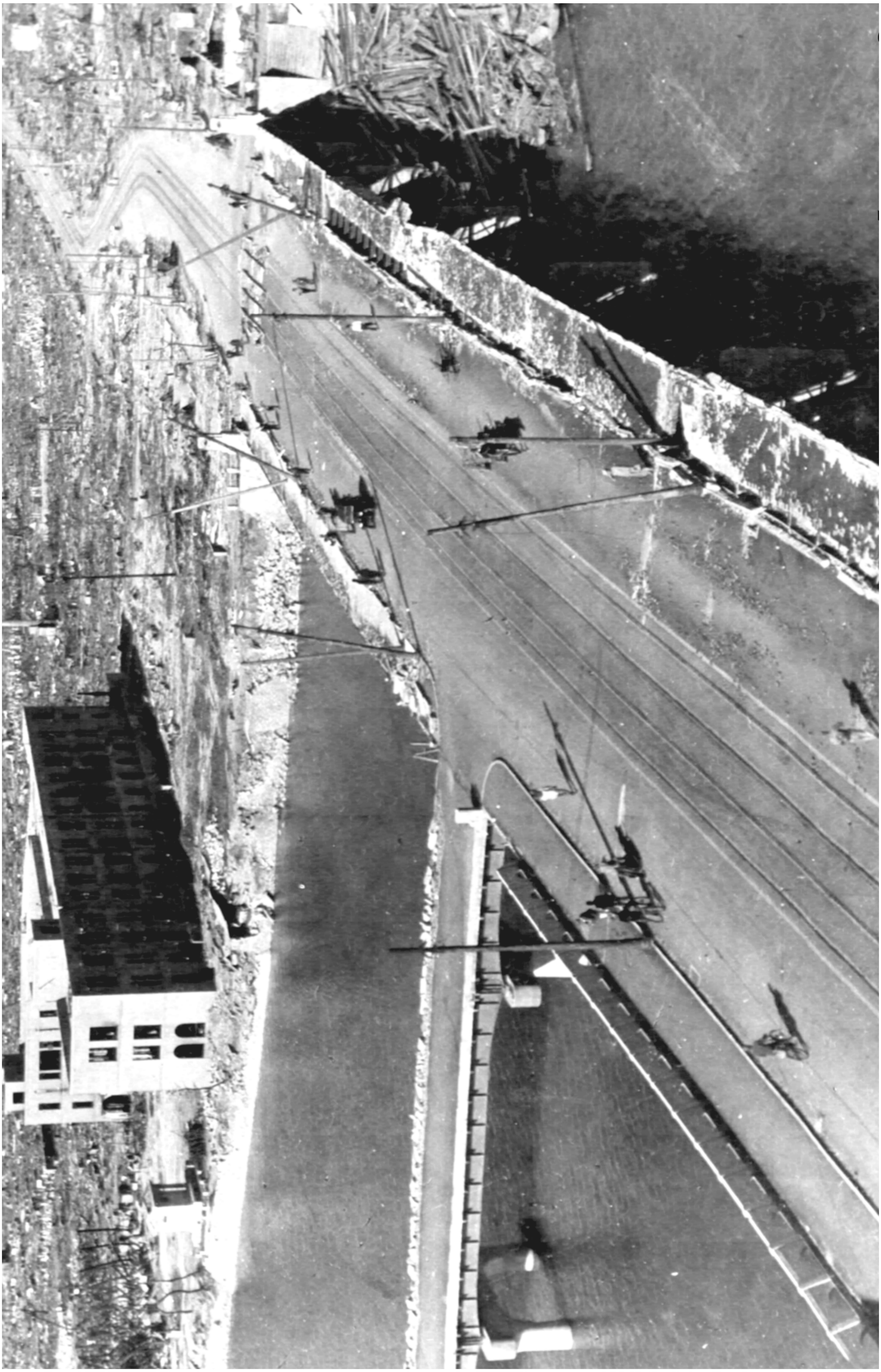
The main Messerschmitt plant at Augsburg was destroyed by over 500 tons of bombs. Thirty buildings and 70% of stored material were destroyed, but only one-third of the machine tools were damaged. Hence, production capacity was reduced by only 35%, and the plant was back in full production in little over 1 month.[6]

The Russians have themselves demonstrated that industrial buildings are not essential to continued production. To protect their aviation industry from German bomber attacks, the Soviets in 1941 used railroad cars to relocate approximately 1,523 industrial enterprises, including 1,360 large war plants, to the Trans-Volga, Urals, Eastern Siberia, and to Kazakhstan and Central Asia. This relocation involved 85% of the entire aviation industry. At many sites, resumption of production began even before temporary facilities were constructed. Machines were set up on temporary platforms in the open, and work was accomplished in weather that reached -40 degrees. Within a year, production rates exceeded the highest rates that had been achieved prior to the relocation.[7]

In order for Americans to judge the true position of the U.S. in a future nuclear confrontation, it is first necessary to establish some perspective as to how damaging a U.S. nuclear retaliatory strike might be to Soviet targets. Briefly summarized, the U.S./USSR survival capabilities are as follows. Given a first strike by the USSR, the U.S. would have on the order of half of its nuclear arsenal (ICBMs, SLBMs, and bombers) surviving. If these weapons were programmed to achieve maximum destruction of industrial targets, the entire U.S. surviving inventory could destroy unprotected people in, at most, 3% of Soviet territory. If the people were protected by simple, foxhole-type shelters, the lethal area that could be imposed by the U.S. surviving arsenal would be reduced to one-third of 1% of the Soviet land mass.†

†The calculations from which these figures are extracted have been furnished to the Committee at a higher classification.

*Aioi Bridge, Hiroshima aiming point, survived*



*Intersection of Bridge 23 (Left) and Bridge 24 (Right). All Damage From Blast Effects. Bridge 23 (860 Feet to Gz, 2,170 Feet to Az). Bridge 24 (1,000 Feet to Gz, 2,230 Feet to Az).*


**Hiroshima zero point: damage was caused by charcoal stoves**

Some critics argue that the Soviet evacuation and industrial protection plans are not viable because, if an evacuation was started, the U.S. could attack the evacuees before they could be fully dispersed. Such an argument is contrary to the U.S. objective of deterrence. It would be illogical for the United States to be in a position in which, to preserve the viability of its doctrine to deter war, its only recourse would be to preemptively attack the Soviet Union and accept the subsequent destruction of the United States.

The growing Soviet defensive and offensive superiority will most likely result not in nuclear war, but rather force the U.S. to make costly concessions to avoid nuclear war. In a future confrontation, should the Soviets execute their civil defense plans, the consequences to the U.S. of escalation to nuclear war would be disastrous, while the consequences might be tolerable to the Soviet Union. It is believed that the USSR could recover within no more than 2 to 4 years whereas the U.S. could not recover in less than 12 years. In such a condition, the so-called "balance of terror" would no longer be balanced.

Present Soviet civil defense capabilities require that the United States make some important policy decisions. One course of action would be to adhere to our present doctrine and try to make nuclear war as unthinkable for the Soviet Union as it now is for the United States. Another course would be to try to make nuclear war as survivable for the United States as it now is for the Soviet Union. There may be some middle ground between these two options.

Following the first course would imply an attempt by the U.S. to overpower the Soviet civil defenses. This would require a massive increase in the U.S. nuclear arsenal, or possibly a search for some new terror weapon that if used would really destroy all mankind. The second course would involve increased emphasis on defenses for the United States; probably some combination of air and civil defenses. Such defenses presumably would make nuclear war more thinkable for the U.S. and hence would be objectionable to some. However, unless we can be assured that nuclear war is unthinkable for the Soviet Union, it must be made survivable for the U.S.

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. . . a civil defense program will permit the United States to maintain its security for less cost and with less nuclear weaponry than would otherwise be required.

## REFERENCES


5. "The Effects of the Atomic Bomb on Hiroshima, Japan," U.S. Strategic Bombing Survey, Physical Damage Division, May 1947.

6. W.F. Craven, *The Army Air Forces in World War II*, Vol. III, University of Chicago Press, 1951, p. 42.

7. "The Relocation of the Soviet Aviation Industry During World War II: A Background Study," prepared by Major Walter Jajko, USAFR, DTS-1, for the Directorate of Soviet Awareness, June 1976.

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Senator PROXMIRE. Well, now, as you may recall, one of the big arguments in finally defeating the ABM was the argument that you could always overcome any defensive measure, at least with respect to the ABM, with a far less expensive offense, in other words, $10 spent in offense would overcome $100 spent in defense, or something like that, roughly in that area.

Are you contending that civil defense wouldn't have anything like that, that it would be cheaper to provide defense in relationship to the offensive cost of overcoming it?

Mr. JONES. Yes, Senator. That is a very important question because it is true, as you have indicated, that the cost leverages against ABM are such that they can be cheaply overcome with offensive forces. Moreover, certain types of civil defenses are also not cost effective. For example, if the United States invested heavily in large population shelters within the cities, we believe it likely that the Soviet Union could overcome those at less cost than it took us to build them.

Some people have brought up the possibility that we would attack the evacuees before they could get away, but the whole deterrence theory is based on the hostage idea. If you blow up the hostage before he gets away, you have no more hostage. Moreover, your adversary is twice as angry at you. Therefore, for the United States to preemptively attack the Soviet evacuees when they start evacuating would be a very suicidal thing to do.

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Senator PROXMIRE. Well, let me just say, what makes me hesitate on this—and I think Congressman Mitchell, too—is that our nuclear arsenal is so colossal, we are told that we have about 15 tons of TNT for every man, woman and child in the world, the equivalent in our nuclear power. The Administration has cut back the budget for civil defense. They haven't increased it; they have cut it back.

I don't know of anybody in the Defense Department—heaven knows they are concerned with the defense of our country; that is their responsibility—who is calling for a big, vigorous civil defense effort.

Is there anyone in the Defense Department that supports your view, any group? Or any defense experts outside the Defense Department who feels that we should consider engaging in this kind of ambitious and very expensive civil defense effort?

Mr. JONES. Yes, sir, I believe that there are a number of people who are concerned in the Department of Defense. They are concerned because they see an imbalance in vulnerability that could lead to a serious problem—despite the size of our nuclear arsenal. Regardless of how many tons of TNT we have for each man, woman and child, we nonetheless, if you look at how much of the Soviet territory our surviving weapons could damage, it is not much. It is only about 3 percent.

Going back to the previous point, I think a large amount of the Soviet civil defense preparation is multipurpose. It certainly can protect against the Chinese. It certainly can also protect against the United States.

I thought it was significant that the Soviets accelerated their civil defense preparations at about the time that we were signing the ABM treaty in 1972.

## APPENDIX

## CIVIL DEFENSE AND THE STRATEGIC BALANCE

Civil defense is not of itself a threatening capability. Both Sweden and Switzerland have extensive and well-prepared civil defense programs. These programs do not threaten either the U.S. or the USSR because neither Sweden nor Switzerland possesses the offensive weaponry to seriously damage either of the two major powers. For this same reason, the Soviet civil defense preparations, although they date from before World War II, did not in earlier years threaten the United States.

However, in 1972 when the SALT I agreements were signed, it was publicly stated that the United States no longer had nuclear superiority; the forces of the two sides were at approximate parity. Since then, the Soviets have initiated concurrent deployment of four new ICBM models, creating serious concerns in the U.S. as to the trends in the strategic balance.

Paul H. Nitze has suggested that there are three different ways in which the strategic balance can be measured:

1. That which each side has *before* a strike
2. That *surviving* to the United States after an initial counterforce strike by the Soviet side
3. That remaining to each side *after an exchange*

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ADDITIONAL QUESTIONS FOR THE RECORD

FOR

T.K. JONES

Question 1.

**On what calculations do you base your estimate that 98% of the Soviet population would survive a massive countervalue attack with the entire U.S. arsenal of 8,500 or more nuclear warheads?**

Answer

First, our estimate is based not on the "entire U.S. arsenal" but on the weapons that the U.S. could optimistically expect to survive a Soviet first strike.

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The Soviet Union was assumed to have no antiballistic missile (ABM) defenses. Soviet air defenses were assumed to have been suppressed even though no U.S. warheads were assumed to be used for this purpose. All U.S. warheads (on SLBMs, bombers, and ICBMs) were assumed to be expended in a retaliatory strike on Soviet urban/industrial areas or on evacuation areas. (This latter assumption is particularly naive since it would leave the United States totally disarmed and leave Soviet military assets largely untouched.)

One fulfillment of this view was the October 1973 Middle East war, where a Soviet threat to intervene caused the United States to restrict deliveries to Israel, thereby bringing about the release of the encircled Egyptian army.

Marshal Grechko's view of the matter was that:

> It was precisely the change in the correlation of forces in favor of socialism and the process of the relaxation of tension taking place on this basis which prevented the dangerous eruption of the war in the Near East from assuming dimensions threatening universal peace.

In Angola, the United States backed down with minimum protest and no effective counteractions. The Soviet leaders could logically view these events as an emerging tendency of the United States to back down in confrontations. Once such a pattern of concessions is established, it is increasingly difficult to halt the process.

As the correlation of forces shifts further in favor of the Soviet Union, it is not unrealistic to believe that the United States would be willing to back down in confrontations even more important than Angola and the Middle East. By 1978, the Soviet Union will have gained a "war-winning" capability comparable to that which the United States held in 1962 during the Cuban missile crisis. (See Figure A-3 of the study report.) The Soviets believe we have rational leadership and that the U.S. leadership, when placed at a major disadvantage, as the Soviets themselves were in 1962, can be forced to acquiesce to Soviets demands in future confrontations.

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Question 24.

What evidence is available to indicate that the Soviet industrial defense measures have been implemented throughout the U.S.S.R. and are not merely "pilot" or "demonstration" programs at a few facilities?

Answer

Soviet civil defense literature and commentary by Soviet civil defense spokesmen over the past several years indicate this is not the case. Soviet newspapers and journals, especially the civil defense monthly, VOY ZNAN (circulation in excess of 300,000), refer to industrial defense measures underway at a broad variety of industry installations. Books such as Civil Defense of an Industrial Installation (2 editions totalling 500,000 copies) indicate nationwide programs.

BROOKHAVEN NATIONAL LABORATORY BNL 917 (C-43)

# ECOLOGICAL EFFECTS OF NUCLEAR WAR

*Proceedings of a Symposium**
*Sponsored by*

THE ECOLOGICAL SOCIETY OF AMERICA

*at the*
*Thirteenth Meeting of*

THE AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES

Amherst, Massachusetts

August 1963

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## Physical Damage From Nuclear Explosions

CARL F. MILLER
*Stanford Research Institute, Menlo Park, California*

(pages 1-10)

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Table 2

Survival Rates at Hiroshima and Nagasaki

| Exposure | Condition | % Survival |
|---|---|---|
| 50-100 $cal/cm^2$ | Outside | 0 |
| | Indoors or shielded | 90-100 |
| 4-6 psi | Outside | 0 |
| | In frame building | 85-90 |
| | In concrete building | 95-100 |
| | In underground shelter | 100 |

The large particles contributing to local fallout consist mainly of fused and sintered grains of soil minerals. Fused particles are spherical, glassy beads and are usually the most highly radioactive. While in a fluid state in the fireball, these particles incorporate a large fraction of the least volatile fission products into a glassy matrix where such fission products are fixed. As the particles cool in the fireball and become viscous, the more volatile fission products (or their daughter products) collect on their surfaces. In this way, the larger of the fallout particles, those first ejected from the fireball, have radionuclide compositions enriched with the least volatile fission products, i.e., volatile element concentration is lowest. The smaller fallout particles, which remain in the rising cloud the longest, have radionuclide compositions enriched in the volatile elements.

Table 3

Contamination Factor, $a_L$,* for Crops

Romney, E.M., Lindberg, R.G., Hawthorne, H.A., Bystrom, B.G., and Larson, K.H. 1963. Contamination of plant foliage with radioactive fallout. *Ecology* **44**, 343-9.

| Distance from ground zero, miles | Red clover | Alfalfa | Wheat | Mixed grasses |
|---|---|---|---|---|
| | | Apple II Shot (Tower) | | |
| 7 | $5.6\times10^{-5}$ (0.0011)** | – | $5.3\times10^{-5}$ (0.0020) | – |
| 48 | $4.2\times10^{-4}$ (0.0066) | – | $6.0\times10^{-4}$ (0.0240) | – |
| 106 | $8.3\times10^{-4}$ (0.0120) | – | $18.0\times10^{-4}$ (0.0580) | – |
| | | Smoky Shot (Tower) | | |
| 132 | – | $2.6\times10^{-3}$ (0.0490) | – | – |
| 259 | – | $4.2\times10^{-3}$ (0.1170) | – | $3.2\times10^{-3}$ (0.0530) |

$$*a_L=\frac{\text{gross activity collected per g dry weight of foliage}}{\text{gross activity collected per sq ft of soil area}}=\frac{\text{sq ft of soil area}}{\text{g dry foliage}}.$$

**Values in parentheses are the fractions retained; they are equal to $a_Lw_L$ where $w_L$ is the foliage surface density in grams of dry foliage per sq ft of soil area.

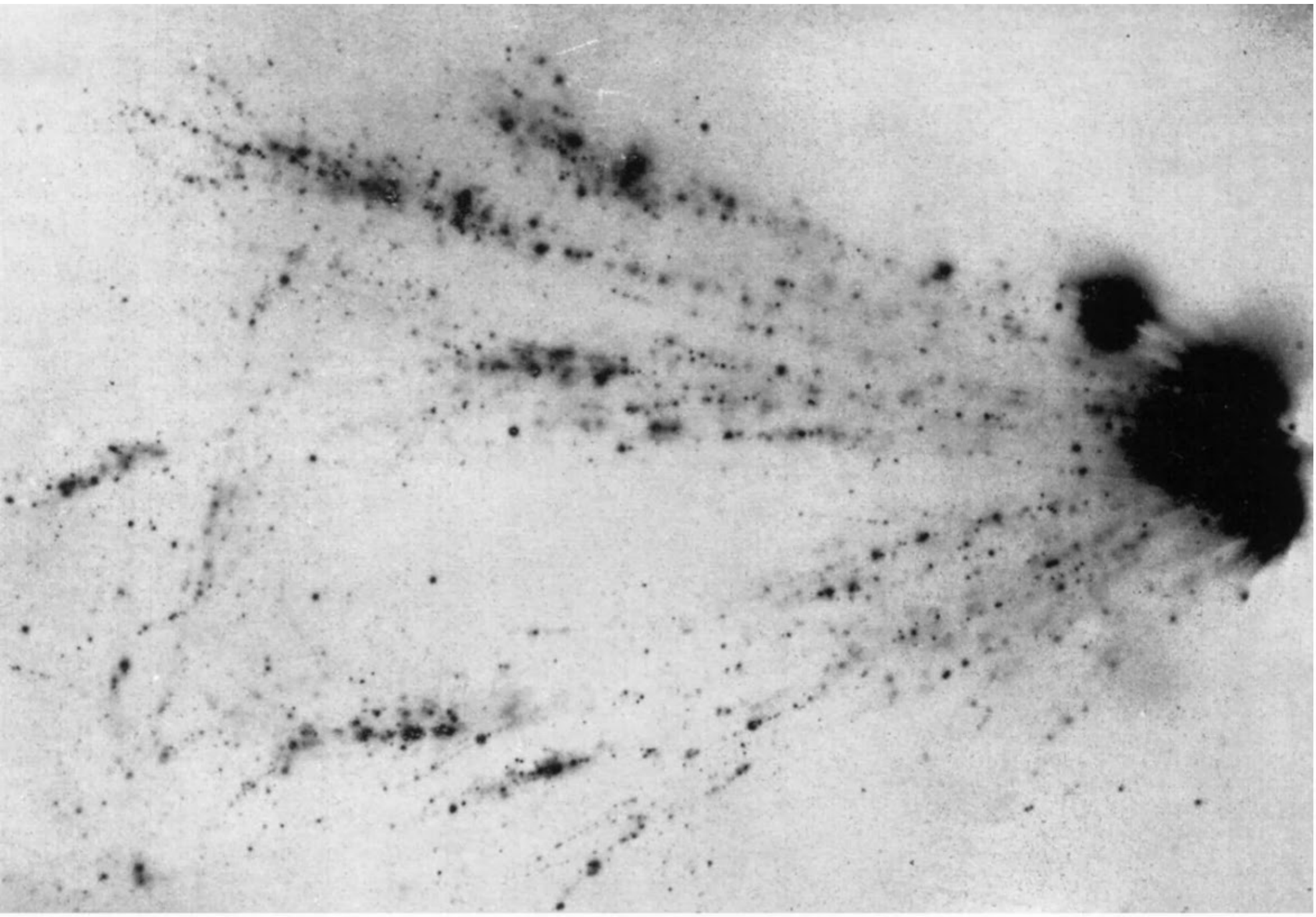
Table 4

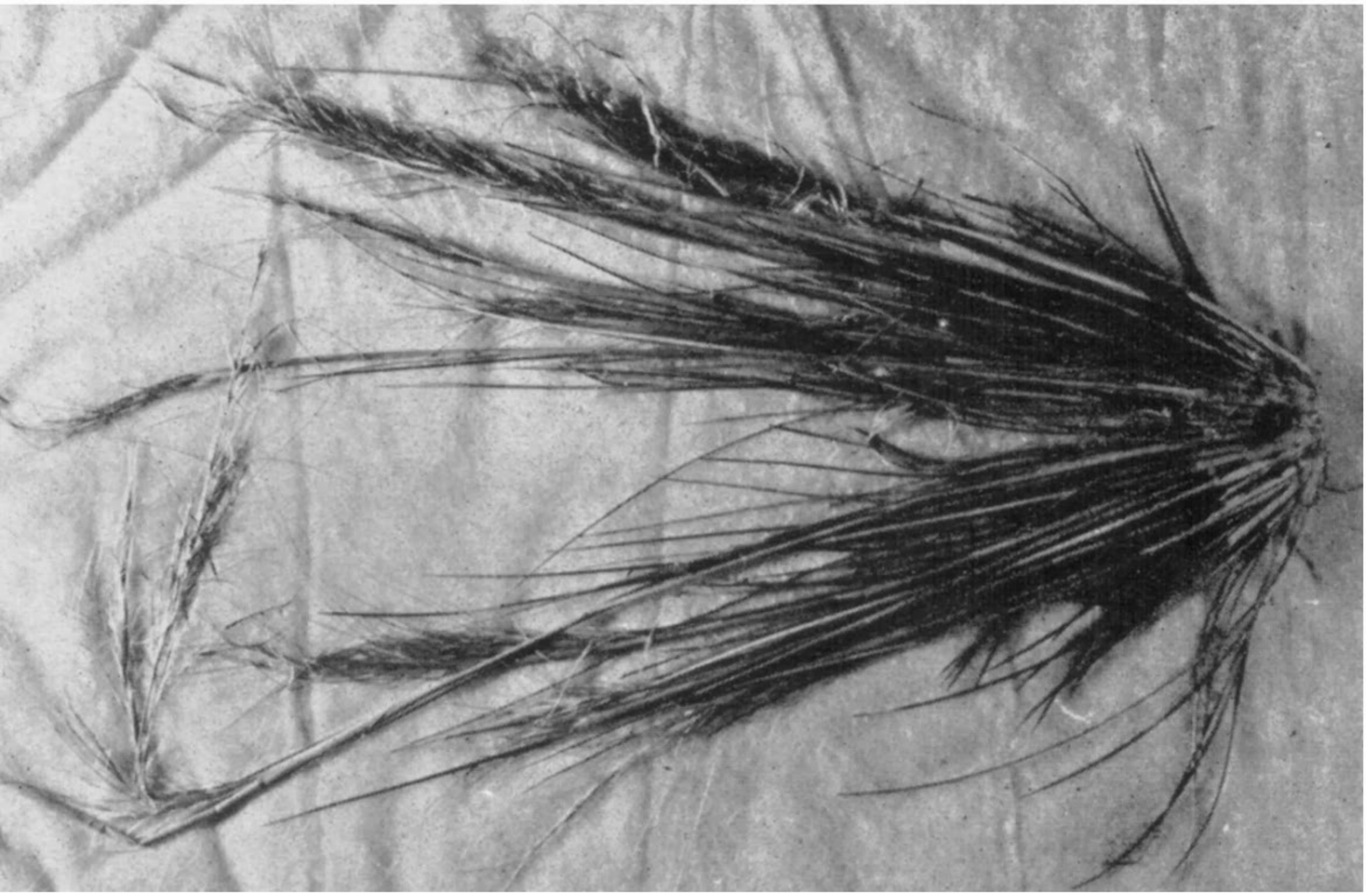
Russell, R.S. and Possingham, J.V. 1961. Physical characteristics of fallout and its retention on herbage. In *Progress in Nuclear Energy*. Series VI, Biological Sciences, Vol. 3, J.C. Bugher et al., Editors. Pergamon Press, New York. Pp. 2-26.

Summary of $a_L$ Values Obtained at Operation Buffalo for Contamination of Rye Grass

| Approximate $I$(max) range, r/h at 1 hr | $a_L$(av), $\frac{\text{sq ft of soil area}}{\text{g foliage}}$ | $a_Lw_L$* |
|---|---|---|
| 0.07–0.15 | 6.8 | 0.15 |
| 0.15–0.30 | 7.1 | 0.16 |
| 0.30–0.60 | 5.9 | 0.13 |
| 0.60–1.00 | 2.7 | 0.06 |
| 1.00–2.00 | 4.0 | 0.09 |
| 2.00–5.00 | 2.9 | 0.07 |
| 5.00–9.00 | 1.4 | 0.03 |

*Where $w_L=22.3$ g foliage/sq ft of soil area (height of grass $=0.33$ ft).



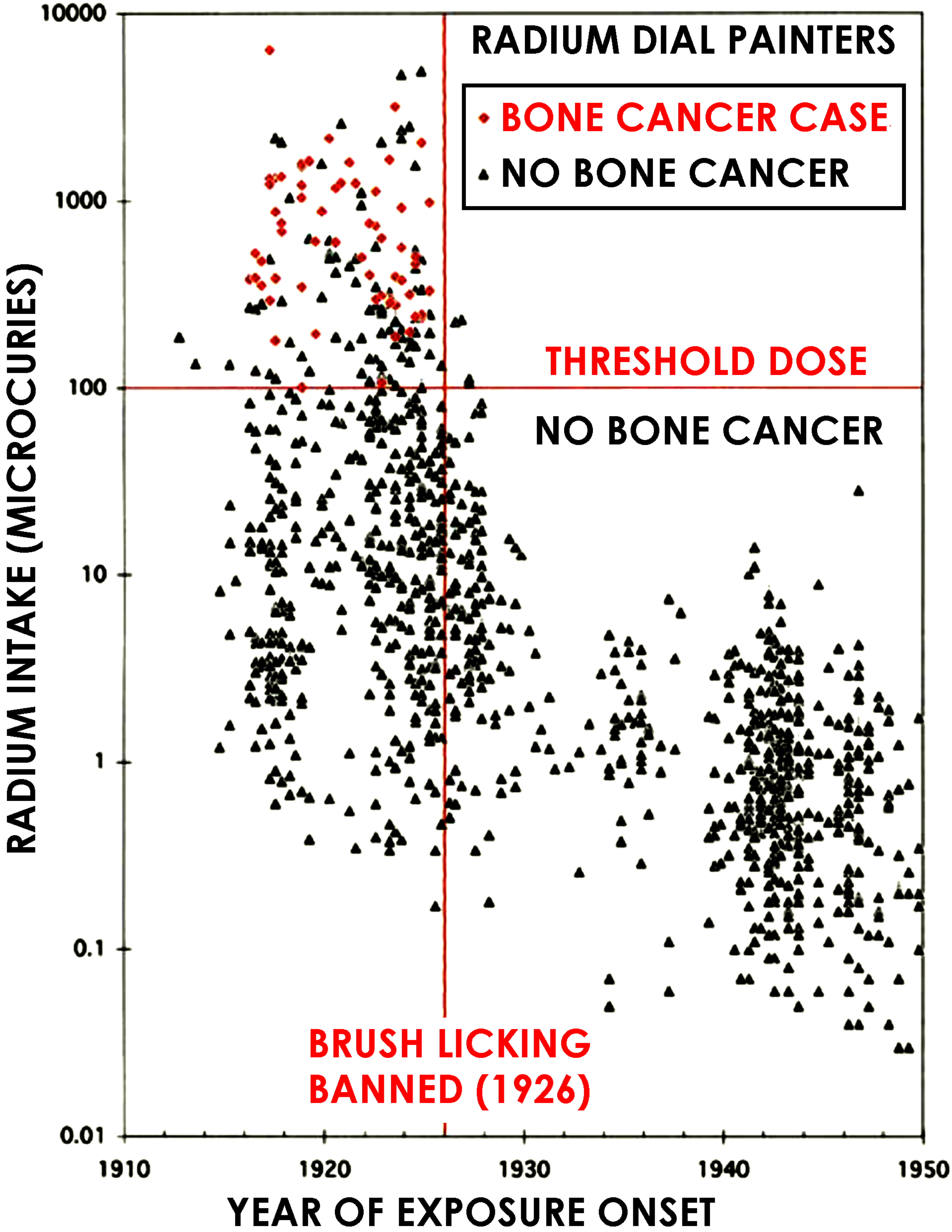


Ryegrass (Lolium perenne) after 15 kt Buffalo-1 tower shot at Maralinga

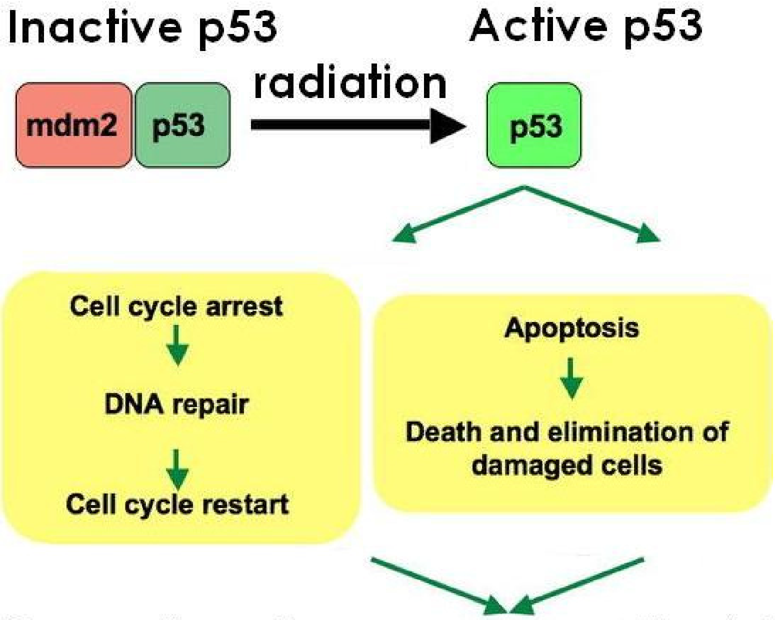
Little dry surface burst silicate fallout is retained

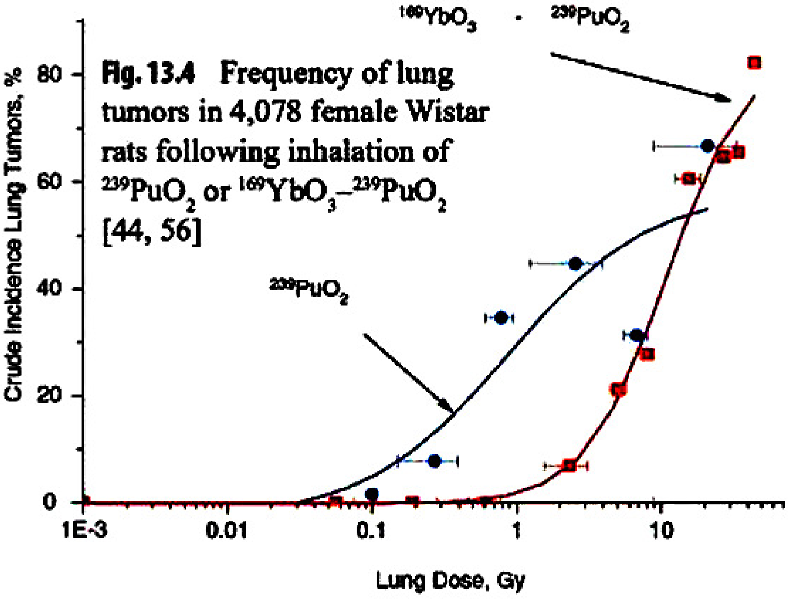
Ryegrass (Lolium perenne) after 1.5 kt Buffalo-2 surface shot at Maralinga, after 2 cm rain

Rowland, R. E. Radium in Humans: A Review of U. S. Studies, Argonne National Laboratory (1994).



Dr C. Sanders, Radiation Hormesis and the LNT Assumption, Springer, 2010

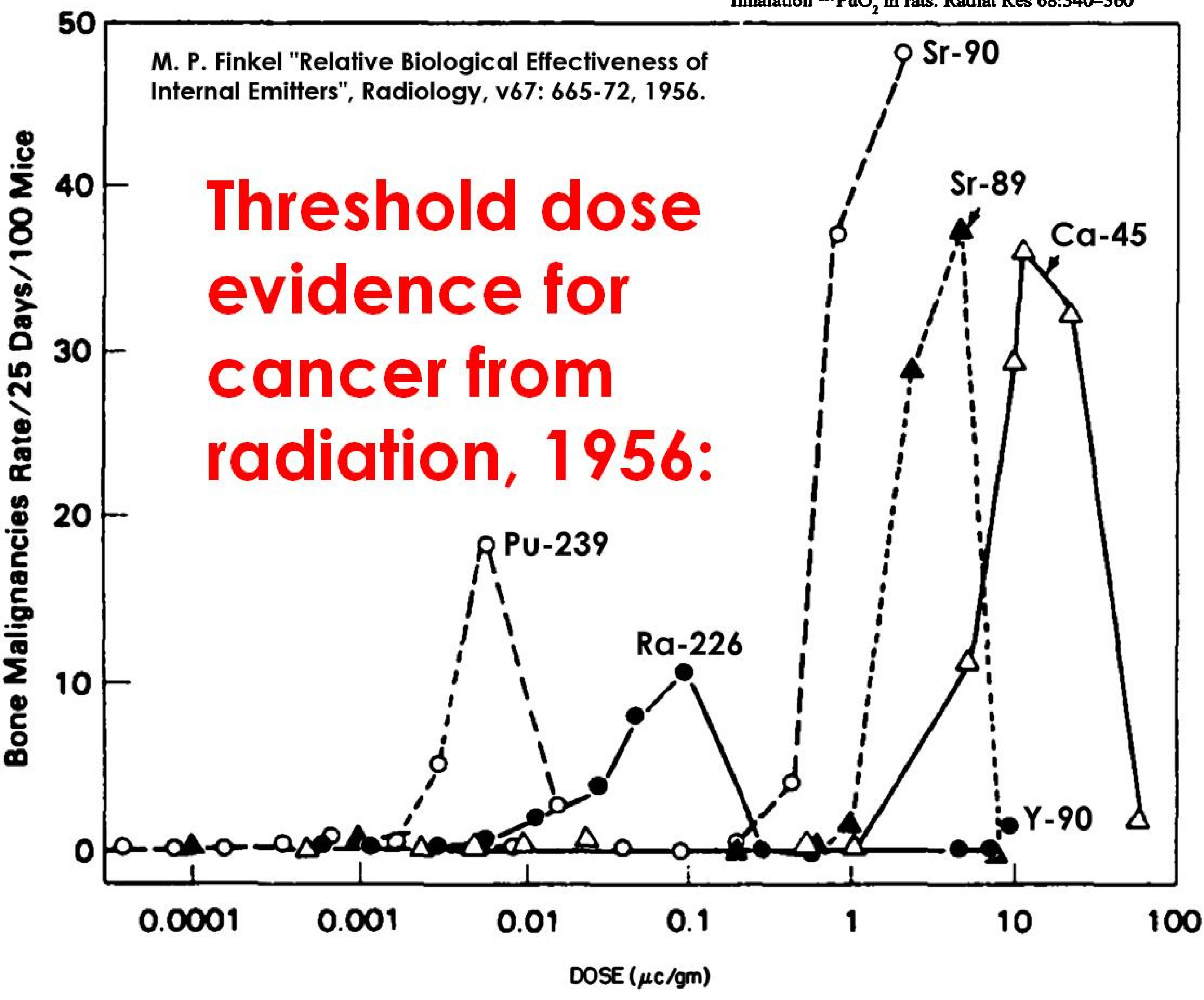


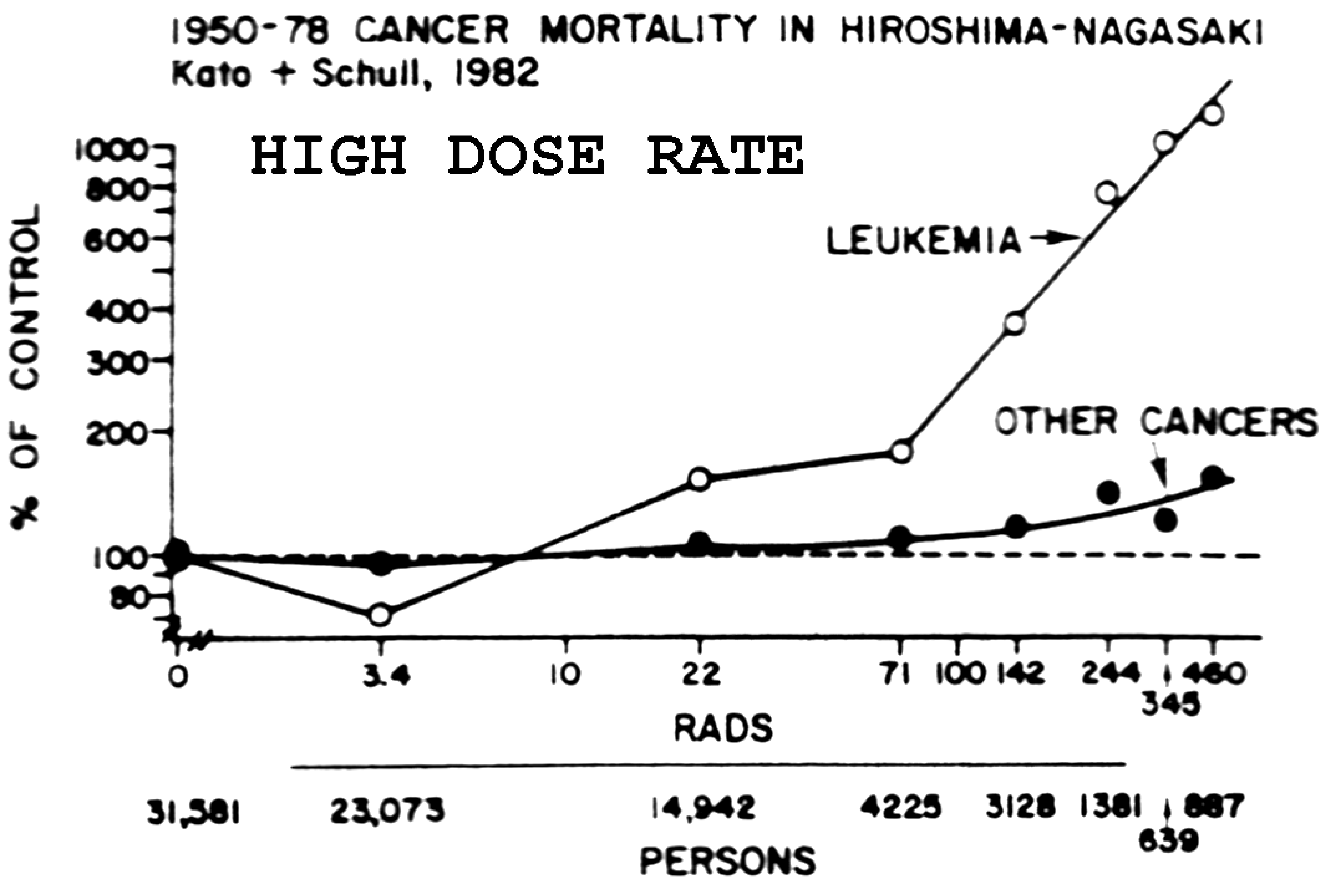




Prevention of cancer or genetic defect
at low dose rates (at high dose rates, double strand DNA breaks are too rapid)


44. Sanders CL, Lauhala KE, McDonald KE (1993) Lifespan studies in rats exposed to $^{239}PuO_2$ aerosol. III. Survival and lung tumors. Int J Radiat Biol 64:417–340

56. Sanders CL, Dagle GE, Cannon WC et al (1976) Inhalation $^{239}PuO_2$ in rats. Radiat Res 68:340–360


1950-78 CANCER MORTALITY IN HIROSHIMA-NAGASAKI
Kato + Schull, 1982
HIGH DOSE RATE
% OF CONTROL
1000
800
600
400
300
200
100
80
LEUKEMIA
OTHER CANCERS
0
3.4
10
22
71
100
142
244
345
460
RADS
31,581
23,073
14,942
4225
3128
1381
639
887
PERSONS

| Dose range milli-sievert | Number in 1950 | Cancer deaths (excl. leukaemia) | | Leukaemia deaths | |
|---|---|---|---|---|---|
| | | total rate | rate from radiation | total rate | rate from radiation |
| Less than 100 | 68467 | 11.2% | 0.09% | 0.2% | 0.01% |
| 100 to 200 | 5949 | 12.3% | 0.7% | 0.2% | -0.01% |
| 200 to 1000 | 9806 | 13.2% | 1.9% | 0.6% | 0.3% |
| More than 1000 | 1829 | 24.1% | 8.1% | 3.5% | 2.4% |
| **All** | **86611** | **11.7%** | **0.6%** | **0.3%** | **0.1%** |

Source: Dr Wade Allison
1 milliSievert = 100 mR

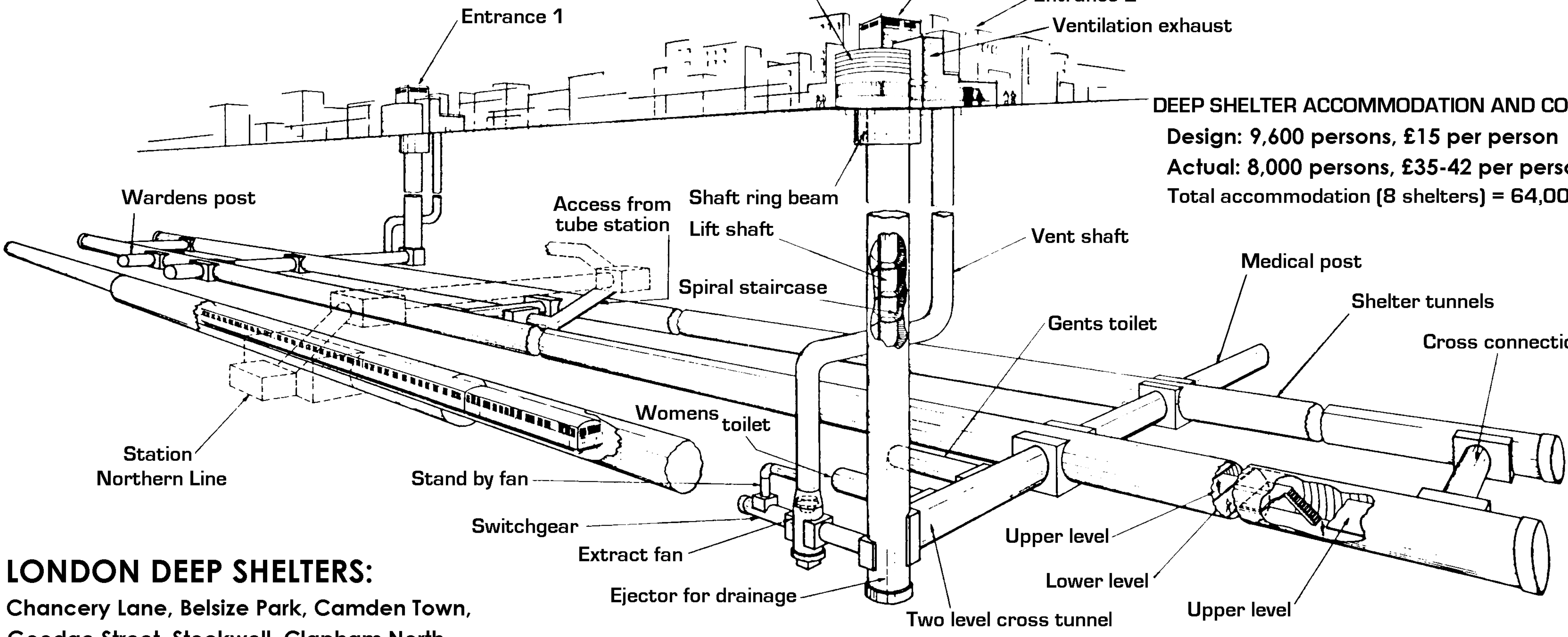
*Cancer deaths among 86611 Hiroshima and Nagasaki survivors, 1950-2000*

*The total radiation-related deaths from solid cancer and leukaemia were 480 and 93, respectively.*

http://www.bioone.org/doi/abs/10.1667/RR3232

**Preston, D. L., Pierce, D. A., Shimizu, Y., Cullings, H. M., Fujita, S., Funamoto, S. and Kodama, K., "Effect of Recent Changes in Atomic Bomb Survivor Dosimetry on Cancer Mortality Risk Estimates," Radiat. Res. v162, pp377–389 (2004).**

UK National Archives: WORK 95/9, 1989-1997,
"Clapham South Deep Tube Shelter: Management"




**DEEP SHELTER ACCOMMODATION AND COST**

**Design: 9,600 persons, £15 per person**

**Actual: 8,000 persons, £35-42 per person**

Total accommodation (8 shelters) = 64,000

FIG. 1

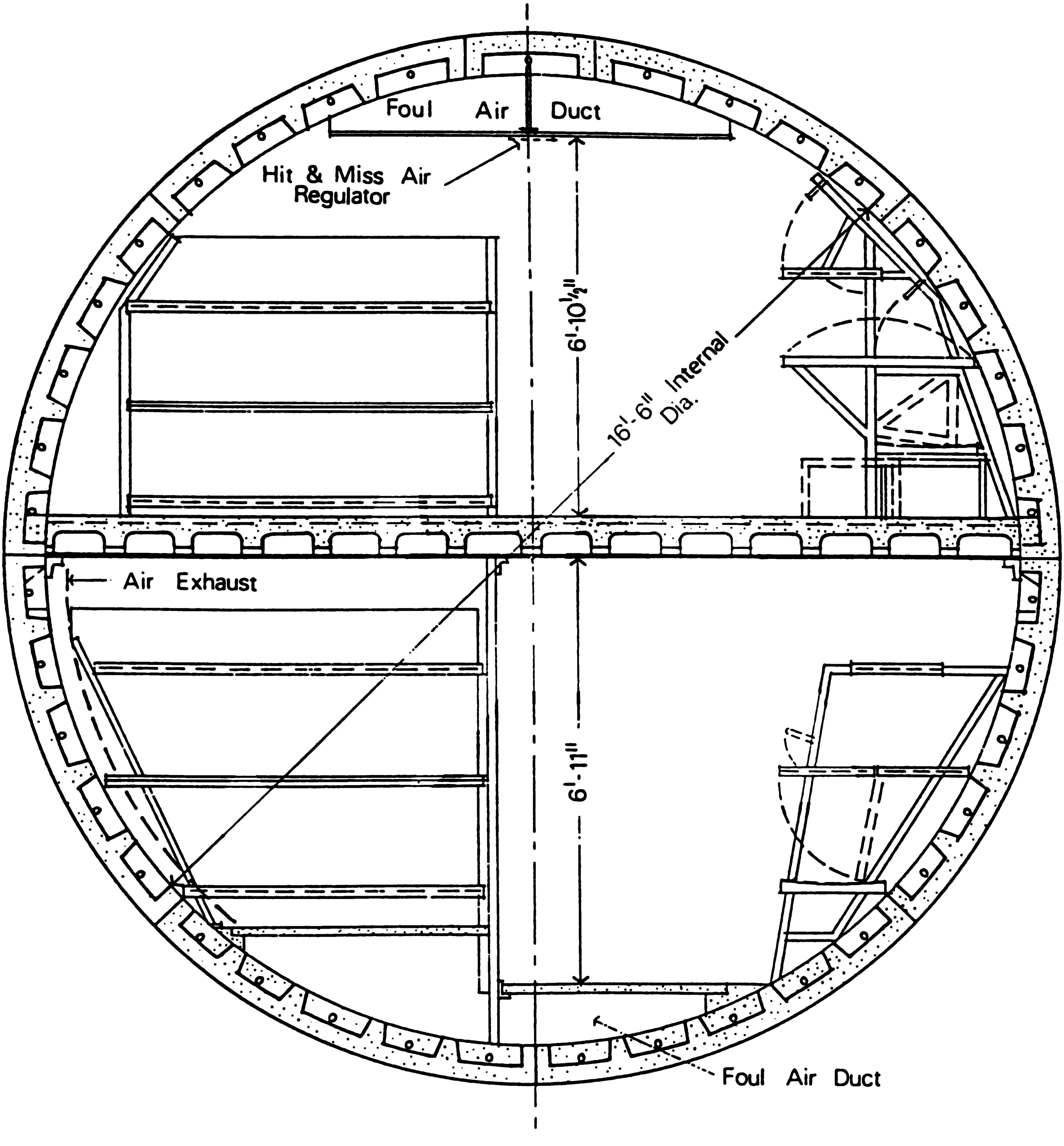
## LONDON DEEP SHELTERS:

Chancery Lane, Belsize Park, Camden Town, Goodge Street, Stockwell, Clapham North, Clapham Common, Clapham South (government air raid shelters, built in 1940-2) Building began on 27 November 1940

Deep shelters were used by public from July 1944 after V1 attacks began on 13 June 1944 (V2s began on 8 September)

**MOTT MAY AND ANDERSON**
**CONSULTING ENGINEERS, LONDON**

UK National Archives: WORK 95/9, 1989-1997, "Clapham South Deep Tube Shelter: Management"




SECTION OF SHELTER TUNNEL

3rd October, 1963. ~~RESTRICTED~~ 9/7/89 For Pro



# HOME OFFICE

# SCIENTIFIC ADVISER'S BRANCH

CD/SA 116

## RESEARCH ON BLAST EFFECTS IN TUNNELS

### With Special Reference to the Use of London Tubes as Shelter

by F. H. Pavry

### Summary and Conclusions

The use of the London tube railways as shelter from nuclear weapons raises many problems, and considerable discussion of some aspects has taken place from time to time. But - until the results of the research here described were available - no one was able to say with any certainty whether the tubes would provide relatively safe shelter or not.

---

The more recent research here described showed for the first time that a person sheltering in a tube would be exposed to a blast pressure only about $\frac{1}{3}$ as great as he would be exposed to if he was above ground. (In addition, of course, he would be fully protected from fallout in the tube.)

---

### Large-Scale Field Test ($^1/40$) at Suffield, Alberta

The test is fully described in an A.W.R.E. report(6). The decision of the Canadian Defence Research Board to explode very large amounts of high explosive provided a medium for a variety of target-response trials that was welcome at a time when nuclear tests in Australia were suspended. A.W.R.E. used the 100-ton explosion in 1961 to test, among other items, the model length of the London tube, at $^1/40$th scale, that had already been tested at $^1/117$ scale.

### Blast Entry from Stations

There was remarkable agreement with the $^1/117$th scale trials: "maximum overpressure in the train tunnels was of the order of $\frac{1}{3}$rd the corresponding peak shock overpressure in the incident blast. The pressures in the stations were about $^1/6$th those in the corresponding incident blast ....... ".

(6) $^1/40$th Scale Experiment to Assess the Effect of Nuclear Blast on the London Underground System. A.W.R.E. Report E2/62. (Official Use Only.)

# 100 ton TNT test on 1000 ft section of London Underground tube at Suffield, Alberta, 3 Aug 1961

**Atomic Weapons Research Establishment, "1/40th Scale Experiment to Assess the Effect of Nuclear Blast on the London Underground System", Report AWRE-E2/62, 1962, Figure 30. (National Archives ES 3/57.)**

| 200 FT FROM GROUND ZERO | 400 FT FROM GROUND ZERO |
|---|---|
| 100 PSI OUTSIDE | 20 PSI OUTSIDE |
| 30 PSI IN TUBES | 7.2 PSI IN TUBES |
| 15 PSI IN TUBE STATIONS | 4.3 PSI IN TUBE STATIONS |


**Aldwych Underground tube station as Blitz shelter, 8 October 1940**

Aldwych tube London 21 Oct 1940: effective Blitz air raid shelter

THOSE WHO WENT TO SHELTERS began a new kind of night-life. Some took over the Tubes, camping out in this fashion—Elephant and Castle Station, 11th November, 1940.

*Tunnel shelters in hillside, very close to ground zero in Nagasaki, protected the occupants from blast, thermal radiation, and immediate nuclear radiation.*

# THE EFFECTS OF THE ATOMIC BOMBS AT HIROSHIMA AND NAGASAKI

## REPORT OF THE BRITISH MISSION TO JAPAN

40. The provision of air raid shelters throughout Japan was much below European standards. Those along the verges of the wider streets in Hiroshima were comparatively well constructed : they were semi-sunk, about 20 ft. long, had wooden frames, and 1 ft. 6 ins. to 2 ft. of earth cover. One is shown in photograph 17. Exploding so high above them, the bomb damaged none of these shelters.

41. In Nagasaki there were no communal shelters except small caves dug in the hillsides. Here most householders had made their own backyard shelters, usually slit trenches or bolt holes covered with a foot or so of earth carried on rough poles and bamboos. These crude shelters, one of which is shown in photograph 18, nevertheless had considerable mass and flexibility, qualities which are valuable in giving protection from blast. Most of these shelters had their roofs forced in immediately below the explosion ; but the proportion so damaged had fallen to 50 per cent. at 300 yards from the centre of damage, and to zero at about ½ mile.

42. These observations show that the standard British shelters would have performed well against a bomb of the same power exploded at such a height. Anderson shelters, properly erected and covered, would have given protection. Brick or concrete surface shelters with adequate reinforcement would have remained safe from collapse. The Morrison shelter is designed only to protect its occupants from the debris load of a house, and this it would have done. Deep shelters such as the refuge provided by the London Underground would have given complete protection.

LONDON

1946

Photo No. 17. HIROSHIMA. Typical, part below ground, earth-covered, timber framed shelter 300 yds. from the centre of damage, which is to the right. In common with similar but fully sunk shelters, none appeared to have been structurally damaged by the blast. Exposed woodwork was liable to "flashburn." Internal blast probably threw the occupants about, and gamma rays may have caused casualties.

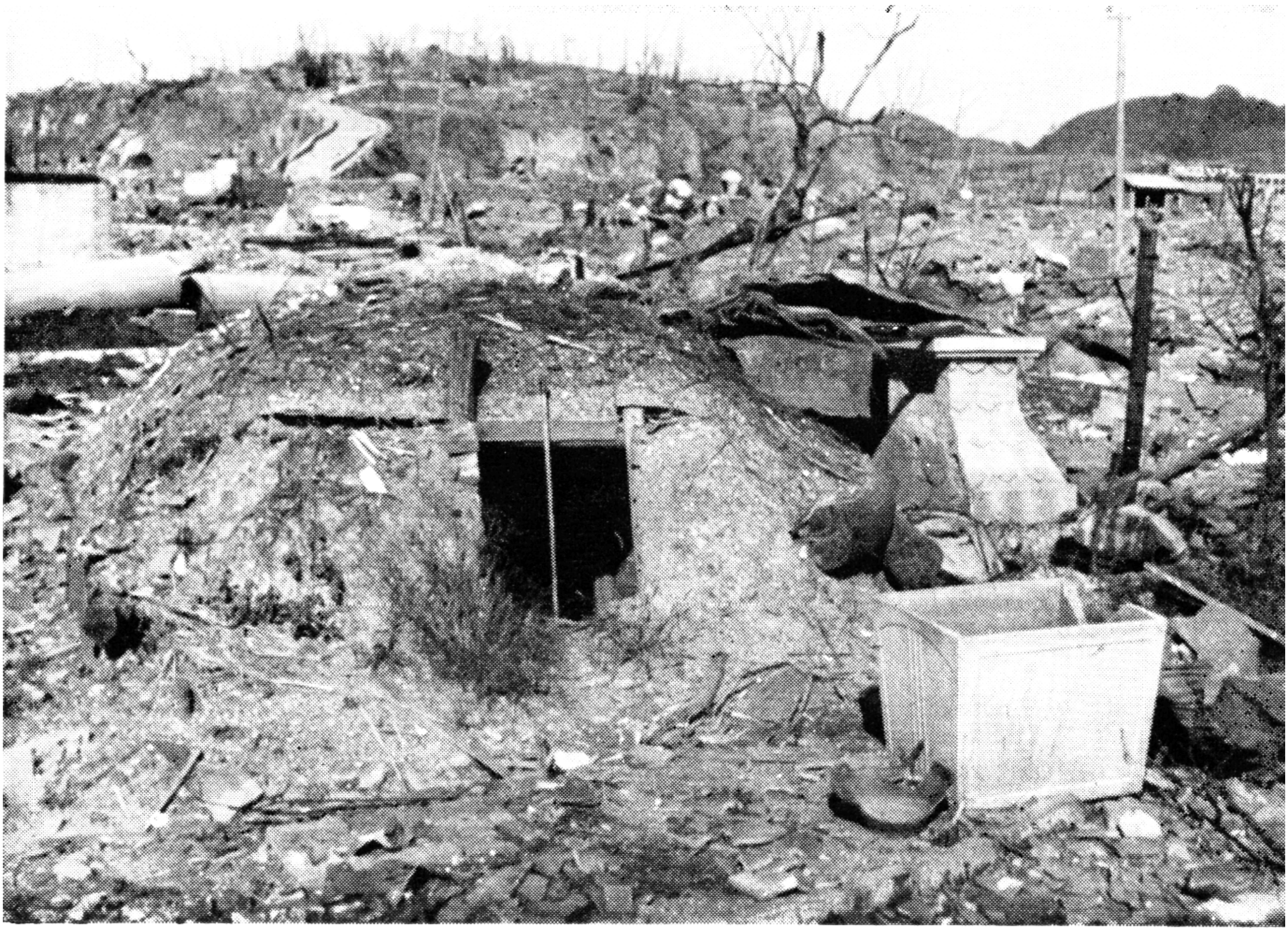


Photo No. 18. NAGASAKI. Typical small earth-covered back yard shelter with crude wooden frame, less than 100 yds. from the centre of damage, which is to the right. There was a large number of such shelters, but whereas nearly all those as close as this one had their roofs forced in, only half were damaged at 300 yds., and practically none at half a mile from the centre of damage.

AIR MINISTRY
AP 3349

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WO
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9466

26/GS Trg Publications/2329

# PRECAUTIONS AGAINST NUCLEAR ATTACK

## 1957

(Superseding Precautions Against Atomic Attack, 1952 (WO Code No. 8769))

*Promulgated by Command of the Army Council,*

E. W. Playfair

*Promulgated by Command of the Air Council,*

J. H. Barnes

Telegraph pole burnt on the side facing the flash. Note where foliage has acted as a shield

Shelter 100 yards from the centre of damage—Nagasaki

## Protection against fall-out

101. Except in the immediate vicinity of a nuclear explosion a reasonably accurate prediction of the area of fall-out can be made in time for a warning to be issued to units in the areas in which it is likely to fall. Given a reasonable warning it may be possible to evacuate the area before the fall-out arrives. In any case simple precautionary measures can greatly reduce the hazard to life.

102. Exposure to the radio-active radiations from fall-out can be reduced by taking shelter and by using simple decontamination procedures until such time as persons can leave the area. In areas where radio-active contamination is heavy it may be necessary to remain under cover for as long as 48 hours before the radiations will have fallen, by natural decay, to levels at which it will be safe for persons to move about, either to leave the area, or, in the case of rescue teams from other areas, to enter it.

103. The estimated degree of protection against the residual radiation to be obtained from buildings, trenches, etc, in a fall-out area is shown at Table 7:—

TABLE 7. **Estimated degree of protection against the residual radiation to be obtained from various buildings, trenches, etc, in a fall-out area**

| Type of building or shelter | INSIDE dose expressed as a fraction of the OUTSIDE dose |
|---|---|
| Slit trench with light board or corrugated iron overhead | $\frac{1}{2}$ |
| Slit trench with 1 ft of earth overhead | $\frac{1}{100}$ |
| Slit trench with 2 ft to 3 ft of earth overhead | $\frac{1}{200}$ to $\frac{1}{300}$ |
| Nissen hut | $\frac{1}{2}$ |
| One storey brick house | $\frac{1}{10}$ to $\frac{1}{20}$ dependent upon wall thickness and shielding afforded by neighbouring houses |
| Two storey brick house | $\frac{1}{10}$ to $\frac{1}{50}$ dependent upon wall thickness and shielding afforded by neighbouring houses |
| Three storey brick house | $\frac{1}{15}$ to $\frac{1}{100}$ dependent upon wall thickness and shielding afforded by neighbouring houses |
| Average two storey house in a built up area | $\frac{1}{40}$ |
| Basements | $\frac{1}{200}$ to $\frac{1}{300}$ dependent upon shielding afforded by neighbouring houses |

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# SCIENTIFIC ADVISERS' BRANCH

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It is issued for the personal use of ...... Mr Shath

SECRET

CD/SA 54

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## Some Aspects of Shelter and Evacuation Policy to meet H-Bomb threat

### 1 Introduction

At the present time, with such air raid shelters as are at present in existence and allowing for the planned evacuation of the priority classes, the deaths from a single hydrogen bomb (assumed to have a power a thousand times that of the Nagasaki atomic bomb) on London would be nearly $2\frac{1}{2}$ million, and from five bombs, one each on London, Birmingham, Liverpool, Manchester and Glasgow over 6 million. The first object of Civil Defence must be to prepare a scheme to reduce this figure. No attempt is made in this note to plan such a scheme, but the effect on casualties of certain arbitrary shelter and evacuation measures is discussed in order to indicate the order of magnitude of the reduction which a properly worked out scheme might be expected to achieve.

### 2 Method of Estimating Deaths

The deaths from a nominal atomic bomb among a population of standard density (43.56 per acre) all in houses have been estimated (CDJPS(EA)(48)14 (Revised)) as 31,000. This is equivalent to everyone within 0.6 miles of the bomb being killed and no one being killed outside this radius. If the generally accepted sealing laws for blast heat and gamma radiation are assumed to apply to hydrogen bombs, then it will be sufficiently accurate for present purposes if we assume that for them everyone is killed within a radius of $0.6 \sqrt[3]{F}$ and no one is killed outside this radius. (Where F is the lower factor of the bomb expressed as a multiple of the lower of the nominal bomb). This assumption ignores the possibility that under certain circumstances there could be a large number of additional casualties due to fall out or radio-active crater debris.

From this and from the known night-time population distribution of our major cities (CD/SA 33), it is a simple matter to calculate the deaths from a bomb of any power on the centre of any particular city.

It must, however, be emphasised that the figures given in this note are deaths only. For the nominal atomic bomb it has usually been assumed that the injured are about equal in number to the killed. For the five hydrogen bombs considered in this note it is fairly certain that the killed would outnumber the injured due to the high population densities in the central (killed) areas as compared with the outer (injured) annuli. However, for the present, no attempt has been made to estimate the number of injured, but in considering the figures given in this note the existence of additional very large numbers of injured must be borne in mind.

### 3 Deaths with no shelter or evacuation

Table 1 shows the deaths that would result from a bomb with a power of 100N, 500N and 1000N on the centre of each of our five largest cities with no shelter or evacuation.

**(N = 20 kt)**

Table 1

Deaths with no evacuation and no shelter

| City | Power of bombs | | |
|---|---|---|---|
| | **2 Mt** | **10 Mt** | **20 Mt** |
| | 100N | 500N | 1000N |
| London | 830,000 | 2,420,000 | 3,340,000 |
| Birmingham | 500,000 | 1,070,000 | 1,360,000 |
| Glasgow | 780,000 | 1,180,000 | 1,330,000 |
| Liverpool | 590,000 | 1,080,000 | 1,280,000 |
| Manchester | 560,000 | 1,070,000 | 1,350,000 |
| Total | 3,260,000 | 6,820,000 | 8,660,000 |

It will be seen that deaths from the five 1000N bombs total over 8.6 million.

**5 x 20 Mt)**

4 Effect of Shelter on deaths

Detailed designs of shelters required to give protection at specified distances from hydrogen bombs of various size, particularly if burst at ground level, have not been worked out. However it is of some interest to see what reduction in deaths would result from shelters of specified performance, even though it is uncertain just what strength and thickness would be required to give that performance. The simplest way of specifying shelter performance is by means of the "Safety Rating" concept developed in CD/SA 48. The safety rating of a shelter was there defined as the saving in life, expressed as a percentage of the deaths without shelter, resulting from the use of the shelter in an area of uniform population density. This shelter with a safety rating of 80 would save 80% of the lives that would have been lost if everyone had been in a house. Put in another way, shelter with a safety rating of 80 would reduce the area within which deaths occurred to one fifth of that for people in houses, and therefore the radius of death to $\frac{1}{\sqrt{5}}$. For a bomb with a power factor of F the equivalent radius of death if everyone is in a shelter with a safety rating of 80 will therefore be $\frac{0.6\sqrt[3]{F}}{\sqrt{5}}$. Similarly for shelter with a safety rating of 90 the radius will be $\frac{0.6\sqrt[3]{F}}{\sqrt{10}}$.

Although, as stated above, the design details of shelters to give these safety ratings have not been determined, it seems probable that surface or trench shelters of rather less than Grade A strength (say 1000 lb/sq.ft.) would be required to give a safety rating of 80, and that a strength of about 2000 lb/sq.ft. would be required for a safety rating of 90. For small street surface shelters the extra cost of an increase in strength of this sort is very small (e.g. the structural cost of a 12"/1000 lb/sq.ft. design is given in CD/SA 48 as £15.2 per person, based on seated capacity) and of a 12"/1400 lb/sq.ft. design as £15.5 per person) and detailed studies may well show that shelters with a higher safety rating than 90 are a practical proposition.

From the formulae for equivalent radii of death given above, and from the population distribution given in CD/SA 33 we can calculate the expected deaths in these two types of shelter under the same conditions of attack as were given in Table 1 for a population all in houses. The results are given in Tables 2 and 3.

Table 2

Deaths with no evacuation but with everyone in a shelter with a Safety Rating of 80

| City | Power of bomb | | |
|---|---|---|---|
| | 2 Mt<br>100N | 10 Mt<br>500N | 20 Mt<br>1000N |
| London | 135,000 | 474,000 | 785,000 |
| Birmingham | 129,000 | 353,000 | 484,000 |
| Glasgow | 223,000 | 576,000 | 760,000 |
| Liverpool | 159,000 | 401,000 | 565,000 |
| Manchester | 117,000 | 386,000 | 540,000 |
| Total | 763,000 | 2,190,000 | 3,134,000 |

**(N = 20 kt)**

Table 3

Deaths with no evacuation but with everyone in a shelter with a Safety Rating of 90

| City | Power of bomb | | |
|---|---|---|---|
| | 2 Mt<br>100N | 10 Mt<br>500N | 20 Mt<br>1000N |
| London | 59,000 | 216,000 | 367,000 |
| Birmingham | 64,000 | 191,000 | 296,000 |
| Glasgow | 115,000 | 327,000 | 489,000 |
| Liverpool | 78,000 | 238,000 | 340,000 |
| Manchester | 49,000 | 186,000 | 315,000 |
| Total | 365,000 | 1,158,000 | 1,807,000 |

---

The considerations discussed above strongly suggest that the right policy against the hydrogen bomb would be to evacuate the central areas of our larger cities and to provide shelter where it is most useful, i.e. in the annulus surrounding the central evacuation area.

---

In the meantime, however, it is of some interest to examine the effect on casualties of an arbitrary evacuation area of radius 5 miles in the case of London and 3 miles in the case of Birmingham, Glasgow, Liverpool and Manchester, in conjunction with shelter having a safety rating of 80 and 90 in the surrounding annulus. In each case the evacuees from the central area are assumed to be accommodated in the surrounding annulus, arbitrarily taken as between 5 and 15 miles in the case of London and between 3 and 7 miles in the case of the other four cities. The factors by which this evacuation would increase the population density in the 'reception' annulus are as follows; London 1.5, Birmingham 1.6, Glasgow 2.5, Liverpool 1.9 and Manchester 1.7. The deaths resulting from an attack with 1000N bombs after this scheme had been implemented are shewn in Tables 4 and 5.

Table 4

Deaths from 1000N bombs after evacuation of 5 mile radius circle for London and 3 mile radius for other cities. Evacuees assumed accommodated in surrounding annulus where they and the original inhabitants are provided with shelter having a safety rating of 80.

**20 Mt**

| City | Position of bomb | | |
|---|---|---|---|
| | Central | 2 miles from centre | In position to cause maximum deaths |
| London | 0 | 0 | 518,000 |
| Birmingham | 0 | 159,000 | 256,000 |
| Glasgow | 0 | 171,000 | 247,000 |
| Liverpool | 0 | 174,000 | 247,000 |
| Manchester | 0 | 164,000 | 257,000 |
| Total | 0 | 668,000 | 1,525,000 |

Table 5

Deaths from 1000N bombs after evacuation of 5 mile radius circle for London and 3 mile radius for other cities. Evacuees assumed accommodated in surrounding annulus where they and the original inhabitants are provided with shelter with a safety rating of 90.

**20 Mt**

| City | Position of bomb | | |
|---|---|---|---|
| | Central | 2 miles from centre | In position to cause maximum deaths |
| London | 0 | 0 | 261,000 |
| Birmingham | 0 | 56,000 | 155,000 |
| Glasgow | 0 | 64,000 | 152,000 |
| Liverpool | 0 | 67,000 | 152,000 |
| Manchester | 0 | 62,000 | 151,000 |
| Total | 0 | 249,000 | 871,000 |

It will be seen from Tables 4 and 5 that, with this scheme of total evacuation of a central area and shelter in the surrounding annulus, a central bomb causes no deaths at all. Clearly, however, the enemy would be aware of our provisions and might well choose to drop his bombs where they would cause maximum casualties. On average, and without allowing for local concentrations which would be bound to occur in the "reception annulus", this would be at about 7 miles from the centre in the case of London and about 4 miles for the other cities. The average deaths from bombs in these worst positions are therefore given in Tables 4 and 5. Comparing these figures with those to Table 1 it will be seen that evacuation plus shelter with a safety rating of 80 has reduced deaths by 82%, and plus shelter with a safety rating of 90 by 90%.

## Conclusion

Without shelter or evacuation, the deaths from an attack with only five hydrogen bombs might total over $8\frac{1}{2}$ million. The primary object of Civil Defence must be to reduce this figure. Neither evacuation alone nor shelter alone could reduce these deaths to a manageable proportion, but with a suitable combination of the two, consisting of the total evacuation of the population of the central areas into the surrounding annuli where shelter would be provided, it should be possible to reduce the maximum deaths from this particular attack to something of the order of one million.

April, 1954.

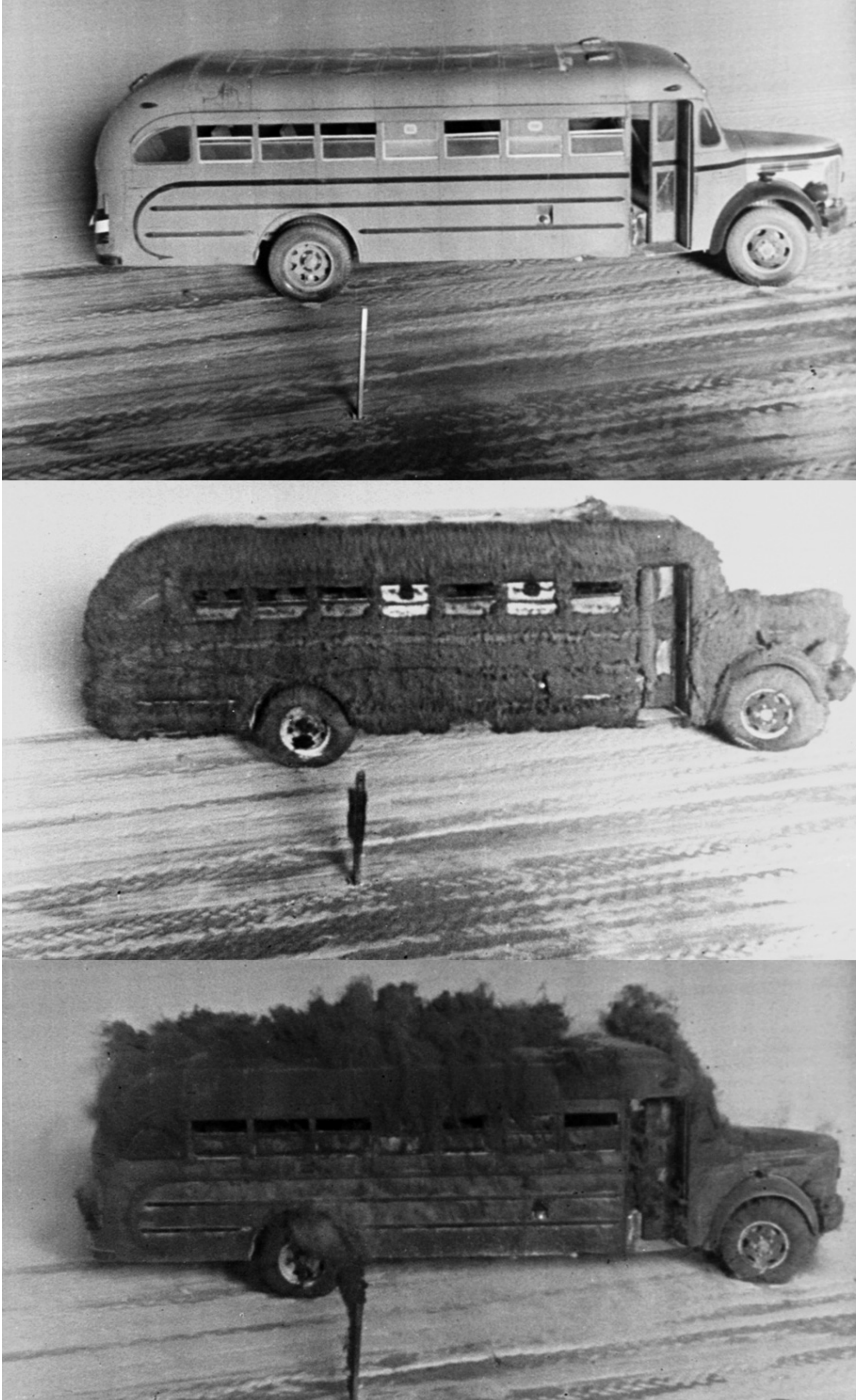
E.L.W. **E. L. W. = Edward Leader-Williams**

OSA.41/4/32. **(who in WWII tested the Morrison shelter while John Fleetwood Baker's colleague)**

## REFERENCES:

**CD/SA 48 = Nat. Archives HO 225/48, "The safety-cost relationship for certain types of surface and trench shelters"**

**CD/SA 72 = Nat. Archives HO 225/72, "Casualty estimates for ground burst 10 megaton bombs"**



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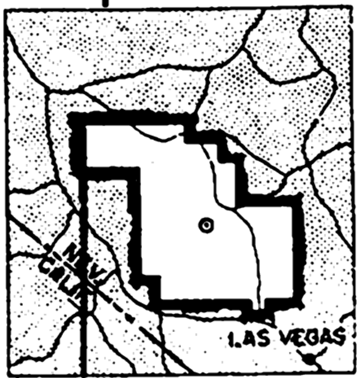


NEVADA TEST SITE
MAY–OCTOBER 1957





Project 8.2

## PREDICTION of THERMAL PROTECTION of UNIFORMS, and THERMAL EFFECTS on a STANDARD-REFERENCE MATERIAL (U)

Issuance Date: May 2, 1960



HEADQUARTERS FIELD COMMAND
DEFENSE ATOMIC SUPPORT AGENCY
SANDIA BASE, ALBUQUERQUE, NEW MEXICO

This material contains information affecting the national defense of the United States within the meaning of the espionage laws Title 18, U. S. C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

1.2.2 Comparison of Skin-Simulant Response and Burns to Pigs. The improved NML skin simulant, molded from silica-powder-filled urea formaldehyde, has the thermocouple embedded at a depth of 0.05 cm in order to give burn predictions based on maximum temperature attainment. The basic criterion is a rise of 25 C or more for a second-degree burn to human skin or for a 2+ mild burn to pig skin. This criterion is based on the assumption of (1) the equivalence of a minimal white burn on the rat skin (or a 2+ mild burn in pig skin) to a second-degree burn in human skin, (2) an initial skin temperature of 31 C, and (3) correspondence of the thermal properties of pig, rat, and human skin. The accuracy of such a burn prediction in terms of indicent radiant exposure is estimated to be ± 10 percent. A skin-simulant temperature rise of 20 C or greater is estimated to correspond to a first-degree human burn or a 1+ moderate pig skin burn, and a rise of 35 C is estimated for a third-degree human burn or a 3+ mild pig burn. The latter estimations, probably accurate to ± 20 percent, are based on pig-burn data obtained at the University of Rochester (Reference 6).



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TABLE 2.1 RADIANT ABSORPTANCES OF SKIN SIMULANT AND STANDARD FABRICS

| Specimen | Radiant Absorptance |
|---|---|
| Skin simulant, bare | 0.72 |
| Skin simulant, blackened | 0.95 |
| Poplin, Shade 116, 5-oz/yd$^2$ | 0.63 |
| Sateen, gray, 9-oz/yd$^2$ | 0.91 |



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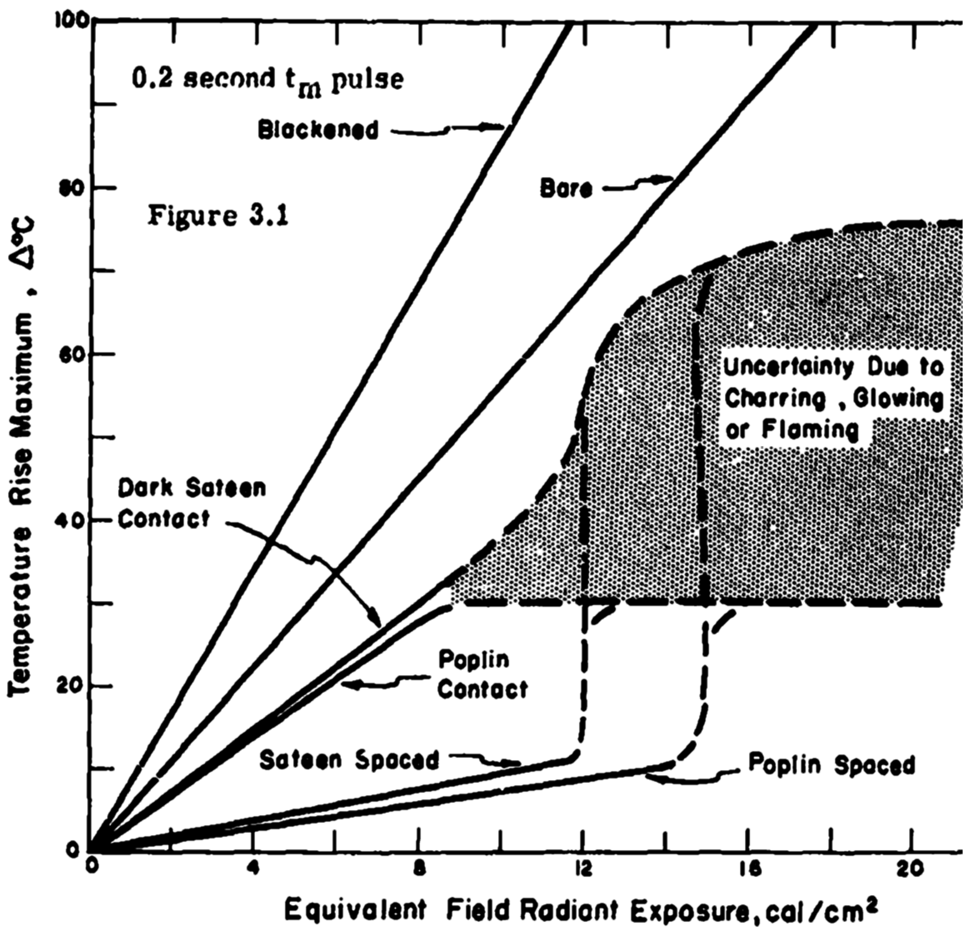
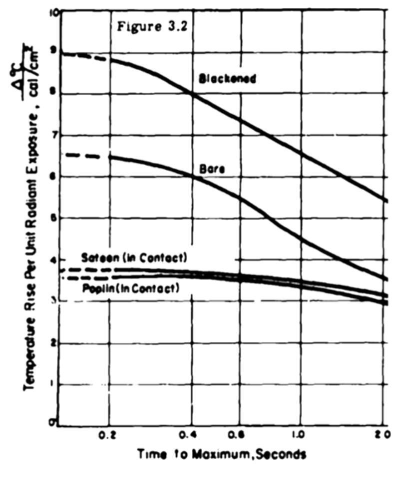



NOTE: These pigs were strapped to tables and could not beat or roll out outer garment ignition unlike humans



# STUDIES ON FLASH BURNS:

# THE PROTECTION AFFORDED BY 2, 4 AND 6 LAYER FABRIC COMBINATIONS

George Mixter, Jr., M. D. and Herman E. Pearse, M. D.

THE UNIVERSITY OF ROCHESTER

## ABSTRACT

Fabric interposed between a carbon arc source and the skin of Chester White pigs increased the amount of thermal energy required to cause 2+ burns. For the 2, 4 and 6 layers of fabric studied this increase was 3.6, 38 and over 104 cal/cm$^2$ respectively when the inner layer of fabric was in contact with the skin. Separation of the inner layer from the skin by 5 mm increased the protective effect of the 2 layer combination from 7.4 to 29 cal/cm$^2$, provided the outer layer was treated for fire retardation. If the outer layer was not so treated, sustained flaming occurred which in itself added to the thermal burn.

## INTRODUCTION

In the past, work in this laboratory has been directed toward a study of flash burns in unshielded skin. It is well known from the atomic bombing in Japan that this type of burn was modified by clothing. A laboratory analysis of the protective effect of fabrics against flash burns was begun (5) by shielding the skin with a few representative fabrics and their combinations.

1. 2 Layers
   a. light green oxford
      knitted cotton underwear
   b. light green oxford (HPM)
      knitted cotton underwear
2. 4 Layers
   olive green sateen
   thin cotton oxford
   wool-nylon shirting
   knitted cotton underwear
3. 6 Layers
   olive green sateen
   thin cotton oxford
   mohair frieze
   rayon lining
   wool-nylon shirting
   knitted wool underwear

5. Morton, J. H., Kingsley, H. D., and Pearse, H. E., "Studies on Flash Burns: The Protective Effects of Certain Fabrics", Surgery, Gynecology and Obstetrics, 94, 497-501 (April 1952).

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OPERATION UPSHOT-KNOTHOLE

Project 8.5

# THERMAL RADIATION PROTECTION AFFORDED TEST ANIMALS BY FABRIC ASSEMBLIES

*REPORT TO THE TEST DIRECTOR*

by

J. Fred Oesterling and Staff

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Walter Reed Army Medical Center
University of Rochester Atomic Energy Project

~~CONFIDENTIAL~~ UNCLASSIFIED

4.1.2 Factors Contributing to the Greater Degree of Thermal Protection in the Field.

There are several conditions encountered in the field, especially at the higher energy levels, but not duplicated in the laboratory (at least not up to the present time) that may account for the fact that like amounts of thermal energy did not produce comparable results in the laboratory and in the field. First, the thermal energy is delivered much more rapidly with the explosion of an atomic bomb than it is in the laboratory. Second, due to smoke obscuration the animals in the field actually received a smaller percentage of the total energy delivered than they did in the laboratory. Third, the blast wave following the explosion tended to extinguish flames and remove char, whereas no such wave was present in the laboratory tests. Fourth, where the heat reached the fabric layer next to the skin, uniform drape (or spacing) provided additional protection in the field.

(2) Motion pictures of clothed animals, exposed to 50.0 and 33.5 cal/cm$^2$ on Shots 9 and 10 respectively, showed heavy clouds

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of black smoke enveloping the animals within 120 ms of the explosion.

(3) The blast wave following the explosion, which has not been duplicated in laboratory applications of thermal energy, has two possible protective effects. First, it can be expected to extinguish flames induced by the radiation in assemblies not treated for fire resistance, thus removing a source of high heat. Although the blast wave may not actually extinguish the flame in all cases,* it can be expected in general to have this effect. Second, the blast wave would tend to remove any char which, if allowed to remain, would act as a heat reservoir and increase the likelihood of a severe burn.

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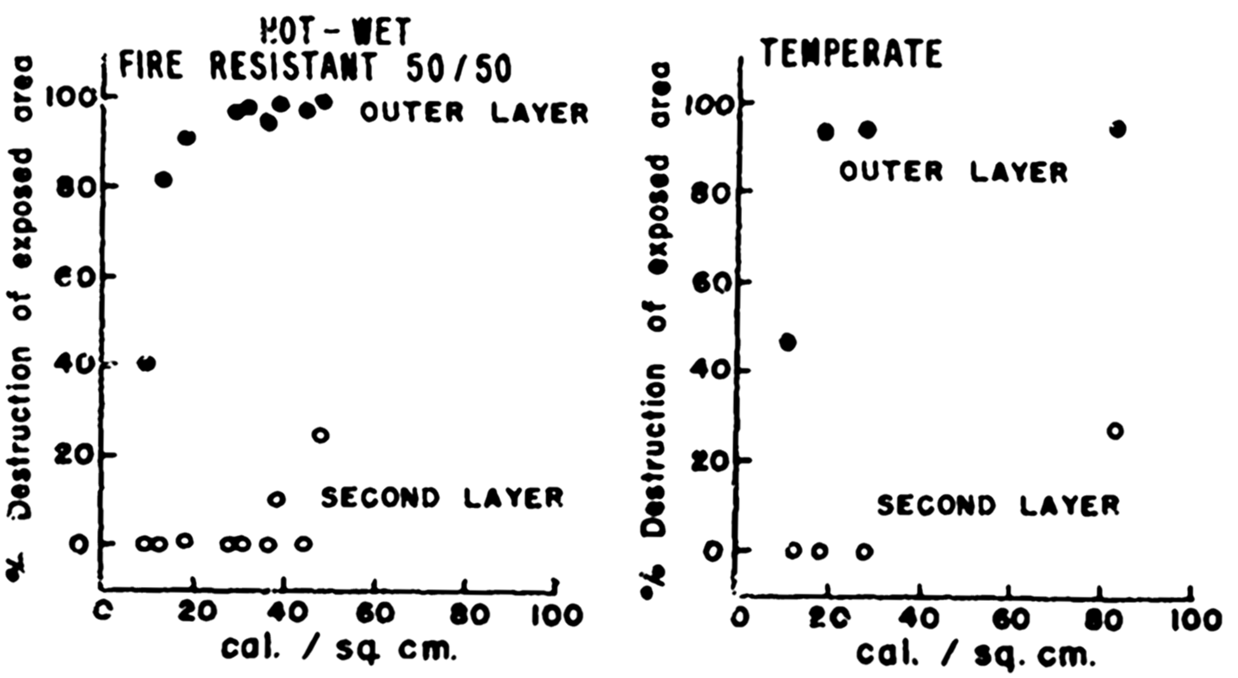
Fig. 3.5 Destruction of Outer and Second Layers of Pigs' Uniforms (Shots 9 and 10)



# cue for survival

## OPERATION CUE

A.E.C. NEVADA TEST SITE

MAY 5, 1955

FEDERAL CIVIL DEFENSE ADMINISTRATION

A report by the FEDERAL CIVIL DEFENSE ADMINISTRATION

## EFFECTS OF NUCLEAR WEAPONS

BY HAROLD L. GOODWIN,
*Director, Atomic Test Operations, FCDA*

The time of travel of the shock wave is not generally understood by many persons. The concept of "duck and cover," which would still be of great value in case of attack without warning, is based on the comparatively large time interval between the burst and arrival of the shock wave at a given point.

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## BIOMEDICAL EFFECTS OF THERMAL RADIATION

BY DR. HERMAN ELWYN PEARSE, *Professor of Surgery at the University of Rochester. Consultant to several Government departments, notably the Atomic Energy Commission's Division of Biology and Medicine. Consultant to the Armed Forces Special Weapons Project*

After the Bikini test, I was asked to go to Japan as a consultant for the National Research Council to survey the casualties in Nagasaki and Hiroshima.

**140**

Then we observed the healing of the wounds, and we found again that the wounds healed in the same manner as those that we had produced in the laboratory. There was some difference in these lesions from the ordinary burns of civil life, but I would predict, from what I learned from experiments, that the difference is on the good side. The burns look worse; they are often charred, but they may not penetrate as deeply, and the char acts as a dressing, nature's own dressing.

**142**

For example, if you have 2 layers, an undershirt and a shirt, you will get much less protection than if you have 4 layers; and if you get up to 6 layers, you have such great protection from thermal effects that you will be killed by some other thing. Under 6 layers we only got about 50 percent first degree burns at 107 calories.

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If we can just increase the protection a little bit, we may prevent thousands and thousands of burns.

... For example, to produce a 50-percent level of second-degree burns on bare skin required 4 calories. When we put 2 layers of cloth in contact, it only took 6 calories. But separate that cloth by 5 millimeters, about a fifth of an inch, and it increases the protective effect 5 times. The energy required to produce the same 50-percent probability of a second-degree burn is raised up to 30 calories. So if you wear loose clothing, you are better off than if your wear tight clothing.

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Abridged

# THE BURN SURFACE AS A PARASITE

## WATER LOSS, CALORIC DEMANDS, AND THERAPEUTIC IMPLICATIONS

Carl Jelenko, III, M.D.

Department of Surgery

University of Maryland School of Medicine and Hospital

Baltimore, Maryland

### Water is Lost through Burned Skin

If, during the first 48 hours after injury, no more fluid is given to an extensively burned patient than he would need in health, the uncompensated loss of fluid from his circulation may cause shock, and if sufficiently severe, death.

### Heat is Lost Necessitating a High Food Intake

To make matters worse, evaporation of moisture from the wound surface saps not only the body's water stores but its energy stores as well. When water evaporates from the burned surface, cooling results and the body loses heat. The larger the burn wound, the more water loss and the more heat or energy loss.

### How Can the Fluid and Heat Losses Be Diminished?

# Think Plastic Wrap as Wound Dressing for Thermal Burns

**ACEP (American College of Emergency Physicians) News**
http://www.acep.org/content.aspx?id=40462

**August 2008**
**By Patrice Wendling**
**Elsevier Global Medical News**

CHICAGO - Ordinary household plastic wrap makes an excellent, biologically safe wound dressing for patients with thermal burns en route to the emergency department or burn unit.

The Burn Treatment Center at the University of Iowa Hospitals and Clinics, Iowa City, has advocated prehospital and first-aid use of ordinary plastic wrap or cling film on burn wounds for almost two decades with very positive results, Edwin Clopton, a paramedic and ED technician, explained during a poster session at the annual meeting of the American Burn Association.

Dr. G. Patrick Kealey, newly appointed ABA president and director of emergency general surgery at the University of Iowa Hospital and Clinics, said in an interview that plastic wrap reduces pain, wound contamination, and fluid losses. Furthermore, it’s inexpensive, widely available, nontoxic, and transparent, which allows for wound monitoring without dressing removal.

THE UNITED STATES
STRATEGIC BOMBING SURVEY

# THE EFFECTS OF THE ATOMIC BOMB ON HIROSHIMA, JAPAN

Volume I

Physical Damage Division

May 1947

## G. CAUSE AND EXTENT OF FIRE

### 1. Conditions Prior to Attack

The city of Hiroshima was an excellent target for the atomic bomb from a fire standpoint: There had been no rain for three weeks; the city was highly combustible, consisting principally of Japanese domestic-type structures; it was constructed over flat terrain; and 13 square miles (including streets) of the 26.5-square-mile city was more than 5 percent built up (i. e., covered by plan areas of buildings). The remainder of the city comprised water areas, parks and areas built up below 5 percent. Sixty-eight percent of the 13-square-mile area was 27 to 42 percent built up and the 4-square-mile city center was particularly dense, 93.6 percent of it being 27 to 42 percent built up.

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*a.* Evidence relative to ignition of combustible structures and materials by heat directly radiated by the atomic bomb and by other ignition sources developed the following: (1) The primary fire hazard was present in combustible materials and in fire-resistive buildings with unshielded wall openings; (2) six persons who had been in reinforced-concrete buildings within 3,200 feet of air zero stated that black cotton black-out curtains were ignited by radiant heat; (3) a few persons stated that thin rice paper, cedarbark roofs, thatched roofs, and tops of wooden poles were afire immediately after the explosion; (4) dark clothing was scorched, and, in some cases, reported to have burst into flame from flash heat; (5) but a large proportion of over 1,000 persons questioned was in agreement that a great majority of the original fires was started by debris falling on kitchen charcoal fires, by industrial process fires, or by electric short circuits.

*b.* Hundreds of fires were reported to have started in the center of the city within ten minutes after the explosion. Of the total number of buildings investigated 107 caught fire, and, in 69 instances, the probable cause of initial ignition of the buildings or their contents was established as follows: (1) 8 by direct radiated heat from the bomb (primary fire), (2) 8 by secondary sources and (3) 53 by fire spread from exposing buildings.

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### 3. Conditions on Morning of Attack

*a.* The morning of 6 August 1945 was clear with a small amount of clouds at high altitude. Wind was from the south with a velocity of about 4½ miles per hour. Visibility was 10 to 15 miles.

(1) Only a few persons remained in the air-raid shelters after the "all-clear" sounded.

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THE UNITED STATES
STRATEGIC BOMBING SURVEY

# THE EFFECTS OF THE ATOMIC BOMB ON HIROSHIMA, JAPAN

## Volume II

Physical Damage Division

Dates of Survey:

14 October–26 November 1945

Date of Publication

May 1947

**4.** The city, consisting principally of Japanese domestic structures, was highly combustible and densely built up. Sixty-eight percent of the 13-square-mile city area was 27 to 42 percent built up and the 4-square-mile city center was particularly dense, 94 percent of it being 27 to 42 percent built up. All the large industrial plants were located on the south and southeast edges of the city.

**8.** Evidence relative to ignition of combustible structures and materials by directly radiated heat from the atomic bomb and other ignition sources was obtained by interrogation and visual inspection of the entire city. Six persons who had been in reinforced-concrete buildings within 3,200 feet of air zero stated that black cotton black-out curtains were ignited by flash heat. A few persons stated that thin rice paper, cedarbark roofs, thatched roofs, and tops of wooden poles were afire immediately after the explosion. Dark clothing was scorched and, in some cases, was reported to have burst into flame from flash heat. A large proportion of over 1,000 persons questioned was, however, in agreement that a great majority of the original fires were started by debris falling on kitchen charcoal fires. Other sources of secondary fire were industrial-process fires and electric short circuits.

**9.** There had been practically no rain in the city for about 3 weeks. The velocity of the wind on the morning of the atomic-bomb attack was not more than 5 miles per hour.

**10.** Hundreds of fires were reported to have started in the center of the city within 10 minutes after the explosion.

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PHOTO 36 IX. Shows partly burned coat of boy who was in open near City Hall (Building 28) 3,800 feet from AZ.

(8) Scores of persons throughout all sections of the city were questioned concerning the ignition of clothing by the flash from the bomb. Replies were consistent that white silk seldom was affected, although black, and some other colored silk, charred and disintegrated. Numerous instances were reported in which designs in black or other dark colors on a white silk kimono were charred so that they fell out, but the white part was not affected. These statements were confirmed by United States medical officers who had been able to examine a number of kimonos available in a hospital. Ten school boys were located during the study who had been in school yards about 6,200 feet east and 7,000 feet west, respectively, from AZ. These boys had flash burns on the portions of their faces which had been directly exposed to rays of the bomb. The boys' stories were consistent to the effect that their clothing, apparently of cotton materials, "smoked," but did not burst into flame. Photo 36 shows a boy's coat that started to smolder from heat rays at 3,800 feet from AZ.

(3300 from GZ)

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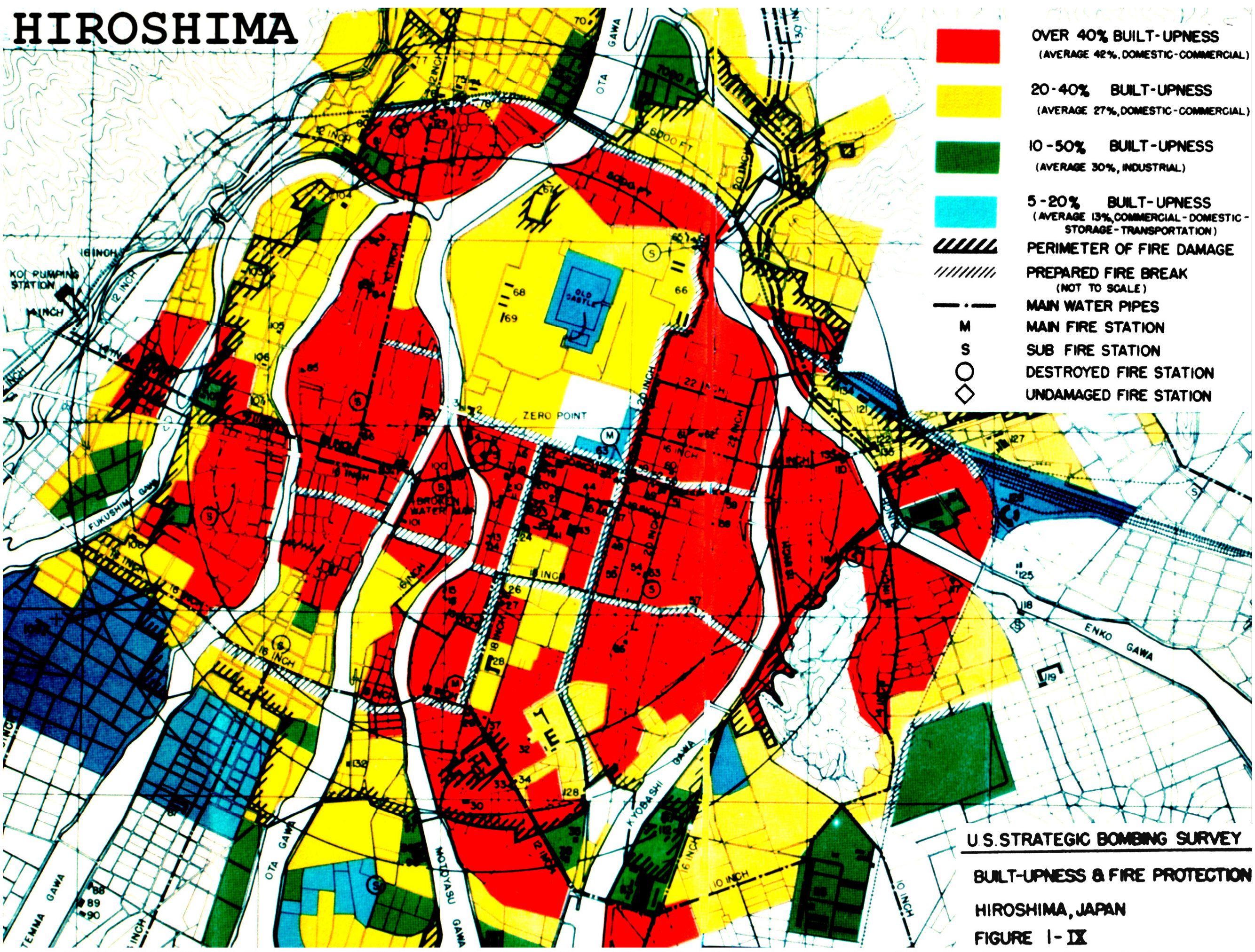


**SOURCE: USSBS's report, "The Effects of the Atomic Bomb on Hiroshima, Japan," vol. 2**
**Only 8 of 64 non-wood buildings had thermal flash ignition evidence, 3 had blast damage induced fire, and 28 were ignited by firespread from wood homes.**

# D. THE CONFLAGRATION

## 1. Start of Fire

*b. Direct Ignition by the Atomic Bomb.* (1) Six persons were found who had been in reinforced-concrete buildings within 3,200 feet of AZ at the time of the explosion and who stated that black cotton black-out curtains were blazing a few seconds later. In two cases it was stated that thin rice paper on desks close to open windows facing AZ also burst into flame immediately, although heavier paper did not ignite. No incidents were recounted to the effect that furniture or similar objects within buildings were ignited directly by radiated heat from the bomb.

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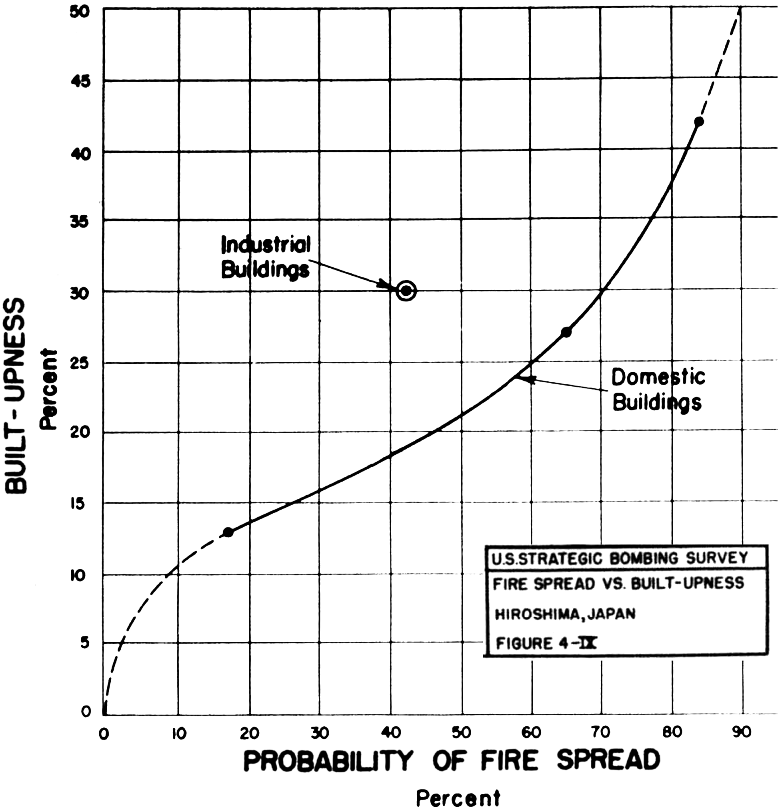


(4) It was reported that a cotton black-out curtain at an unprotected window in the east stair tower of Building 85 (3,800 feet from AZ) smoked and was scorched by radiated heat from the bomb but it did not burst into flames.

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(5) A man who was in the third story of building 26 (3,000 feet from AZ) stated that radiated heat from the bomb ignited cotton black-out curtains at unprotected windows in the west wall and thin rice paper on desks.

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(10) Fire fighting with water buckets was reported inside only four buildings (24, 33, 59, and 122) and probably prevented extensive fire damage in them. In Building 24, fire was started in contents of a room at the southwest corner of the second story by sparks from trees on the south side about 1½ hours after the attack. Men inside the building extinguished the fire and probably prevented further damage in the first and second stories (Photo 85). A little later, contents in the third story were ignited by sparks from the outside and were totally damaged. This fire was beyond control before it was discovered, but did not spread downward through open stairs. At Building 33, sparks from the west exposure, which burned in early evening, set fire to black-out curtains in the west wall and to waste paper in the fourth story of the northwest section of the building. Twenty persons were on guard in the building awaiting such an occurrence and the fires were quickly extinguished while in the incipient stage. At Building 59 sparks from the south exposure ignited a few pieces of furniture in the first and third stories and black-out curtains in the first story about 2 hours after the attack. These fires were extinguished by men inside and negligible damage resulted. A few window frames in the east and west walls and 2 or 3 desks in the first story of Building 122 were ignited by radiated heat and sparks from the west and northeast exposures. These fires were extinguished quickly and damage was negligible.

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# A. SUMMARY

**4.** The mean areas of effectiveness (MAE) of the atomic bomb for structural damage about ground zero (GZ) and the radii of the MAE's for the several classes of buildings present were computed to be as follows:

| | MAE's in square miles | Radii of MAE's in feet |
|---|---|---|
| Multistory, earthquake-resistant | 0.03 | 500 |
| Multistory, steel- and reinforced-concrete frame (including both earthquake- and non-earthquake-resistant construction) | .05 | 700 |
| 1-story, light, steel-frame | 3.4 | 5,500 |
| Multistory, load-bearing, brick-wall | 3.6 | 5,700 |
| 1-story, load-bearing, brick-wall | 6.0 | 7,300 |
| Wood-frame industrial-commercial (dimension-timber construction) | 8.5 | 8,700 |
| Wood-frame domestic buildings (wood-pole construction) | 9.5 | 9,200 |
| Residential construction | 6.0 | 7,300 |

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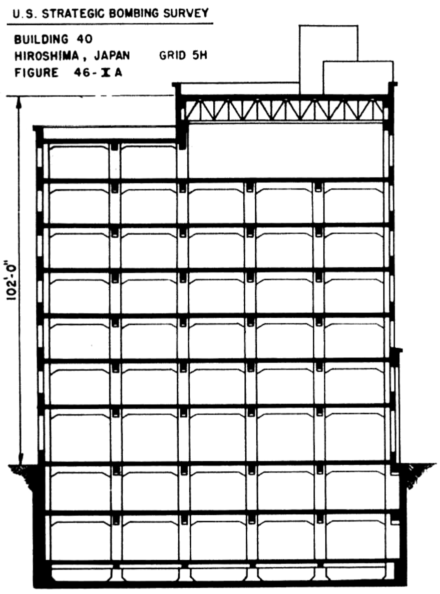
| USSBS Report 92, v2 Hiroshima buildings | MAE's in square miles | Radii of MAE's in feet |
|---|---|---|
| Multistory, earthquake-resistant | 0. 03 | 500 |
| Multistory, steel- and reinforced-concrete frame (including both earthquake- and non-earthquake-resistant construction) | . 05 | 700 |
| 1-story, light, steel-frame | 3. 4 | 5, 500 |
| Multistory, load-bearing, brick-wall | 3. 6 | 5, 700 |
| 1-story, load-bearing, brick-wall | 6. 0 | 7, 300 |
| Wood-frame industrial-commercial (dimension-timber construction) | 8. 5 | 8, 700 |
| Wood-frame domestic buildings (wood-pole construction) | 9. 5 | 9, 200 |
| Residential construction | 6. 0 | 7, 300 |

**Building No.: 26. Coordinates: 5H. Distance from (GZ): 2,300, (AZ): 3,000.**
**NAME: Chugoku Electric Co.**
**CONSTRUCTION AND DESIGN**
**Type: Reinforced-concrete frame.**
**Number of stories: 5 and basement and penthouse JTG class: E1.**
**Walls: Reinforced concrete (12-inch).**

**REMARKS: Fire throughout building except in 60 percent of basement (no fire in basement of west section and about 25 percent of east section). Man who was in third story stated that he saw cotton blackout curtains in west wall and thin paper on desks catch fire from flash of bomb. Fire was reported to have been in all stories 5 minutes after bomb.**

**Building No.: 40. Coordinates: 5H. Distance from (GZ): 2,500, (AZ): 3,200.**
**NAME: Fukuya Department Store.**
**CONSTRUCTION AND DESIGN:**
**Type: Reinforced-concrete frame.**
**Walls: 8-inch reinforced concrete—large windows.**

**REMARKS: Three persons who were questioned individually stated that this building was afire immediately or within 20 minutes after the bomb. One man who was in the building at the time stated that cotton blackout curtains in the west wall were smouldering immediately after the bomb. The entire building was afire at 1000 hours.**




**Building No.: 24. Coordinates: 5H. Distance from (GZ): 1,300, (AZ): 2,400.**
**NAME: Bank of Japan, Hiroshima branch.**
**CONSTRUCTION AND DESIGN**
**Type: Reinforced-concrete frame (steel core).**
**Walls: Reinforced concrete (12-inch) and stone (6-inch).**
**Floors: Reinforced concrete.**
**Framing: Reinforced concrete.**

**REMARKS: Fire only in room at southwest corner of second story and in entire third story. No fire in building right after bomb, but afire at 1000 hours. Fire in room in second story extinguished with water buckets.**

**Building No.: 33. Coordinates: 6H. Distance from (GZ): 5,300, (AZ): 5,600.**
**NAME: Hiroshima Postal Savings Bureau.**
**CONSTRUCTION AND DESIGN**
**Type: Reinforced-concrete frame.**
**Number of stories: 4 and basement. JTG class: E1.**
**Roof: Reinforced concrete, tile finish.**
**Partitions: Reinforced concrete.**
**Walls: Reinforced concrete, tile finish.**

**REMARKS: Sparks from west exposure ignited cotton black-out curtains in west wall at 2000 hours and waste paper in fourth story of northwest section at 2100 hours. Fires were extinguished with water buckets by 20 fire guards who were stationed inside. Fire damage to contents was negligible. Paper records stored in wood and steel racks in northeast section of building were exposed to direct radiated heat from bomb but did not catch fire.**

Building No.: 86. Coordinates: 5G. Distance from (GZ): 2,000, (AZ): 2,800.

NAME: Kōkō Private Grammar School.

CONSTRUCTION AND DESIGN

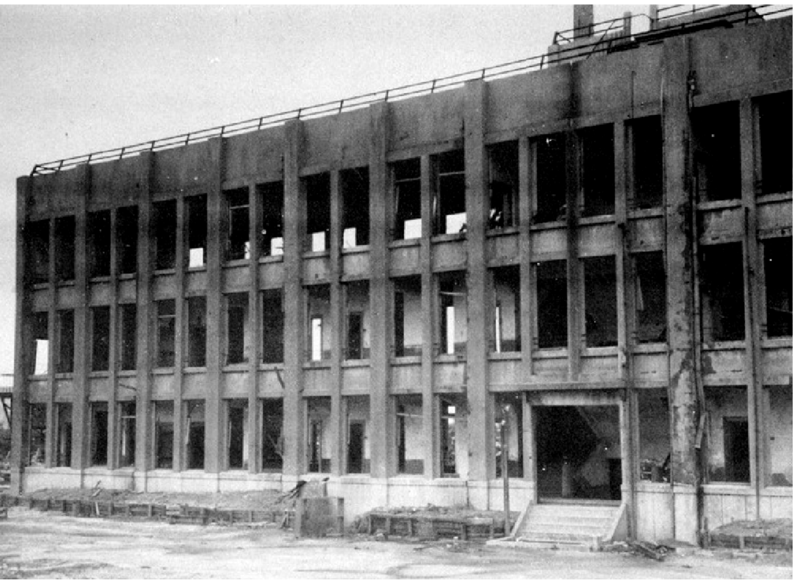
Type: Reinforced concrete.

Number of stories: Three. JTG class: E1.

Roof: Reinforced-concrete slab.

Partitions: 9-inch brick and 6-inch reinforced concrete.

Walls: Reinforced concrete (8–10 inches).



Building No.: 59. Coordinates: 5I. Distance from (GZ): 4,100, (AZ): 4,500.

NAME: Geibi Bank Co., Hiroshima Branch (in use at time of bomb as the Higashi Police Station).

CONSTRUCTION AND DESIGN

Type: Reinforced-concrete frame.

Walls: 8-inch reinforced concrete monolithic—medium window.

EXTENT OF FIRE: Total floor area: 16,200 square feet. Floor area burned: 0 square feet; 0 percent (after blast damage).

REMARKS: Sparks from south exposure ignited few pieces of furniture in first and third stories and cotton blackout curtains in first story about 1030 hours. Fires were extinguished with water buckets by people inside. Negligible fire damage resulted. Some of exposing buildings had just been removed prior to the bomb.

Building No.: 49. Coordinates: 5I. Distance from (GZ): 3,000, (AZ): 3,600.

Name: Chūgoku Newspaper.

CONSTRUCTION AND DESIGN

Type: Reinforced-concrete frame.

Number of Stories: 7 and penthouse. JTG class: E1.

Roof: Reinforced-concrete beam and slab.

Partitions: Reinforced concrete—lath and plaster.

Walls: 7-inch reinforced concrete—large windows.

REMARKS: Man who was in building at time of bomb stated fire broke out in third and fourth stories immediately after bomb flash. Head bookkeeper in bank in Building 51 stated that there was fire in third story of Building 49, 10 minutes after bomb flash.

Building No.: 96. Coordinates: G5. Distance from (GZ): 400 (AZ): 2,000.

NAME: Taisho Clothing Store.

Walls: Reinforced concrete (10-inch)

Building No.: 10 Coordinates: 5H. Distance from (GZ): 600, (AZ): 2,100.

NAME: Nippon Life Insurance Co., Hiroshima branch.

CONSTRUCTION AND DESIGN

Type: Load-bearing brick wall.

Number of stories: See drawing. JTG class: F2.

Roof: Reinforced-concrete slab 6 inch (¼-inch bars 6-inch oc by 12 inch oc).

Building No.: 18. Coordinates: 5H. Distance from (GZ): 1,000, (AZ): 2,200.

NAME: Geibi Bank Co., Hiroshima Branch.

CONSTRUCTION AND DESIGN

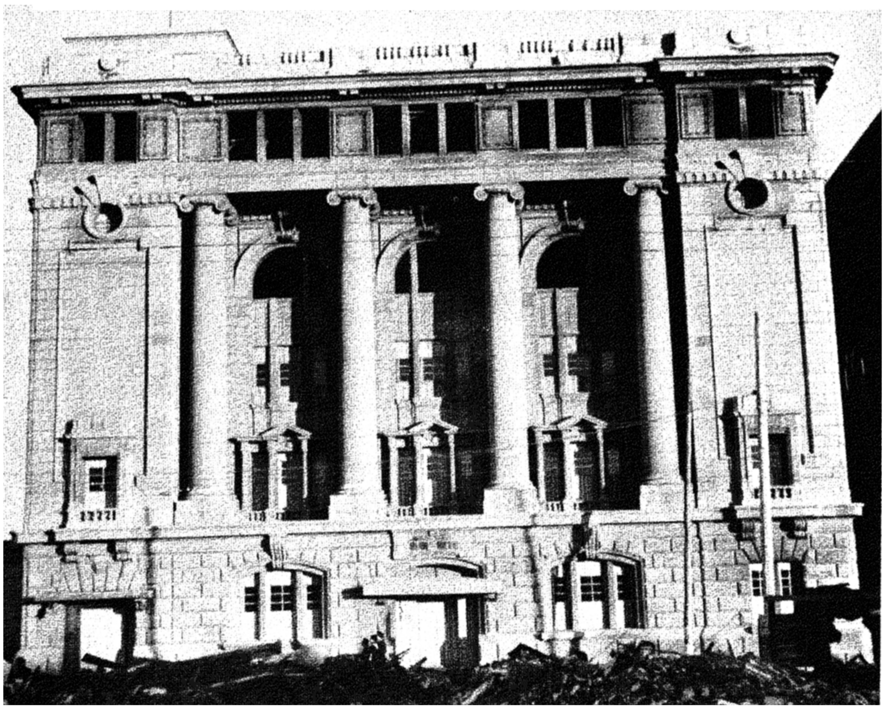
Type: Reinforced-concrete frame.

Number of stories: 5 and ½ basement. JTG class: E1.

Roof: Reinforced-concrete slab (metal pan).

Partitions: Reinforced-concrete (5-inch). Wood lath and plaster in rear addition.

Walls: Reinforced concrete (10-inch).



Building No.: 23. Coordinates: 5H. Distance from (GZ): 1,200; (AZ); 2,300.

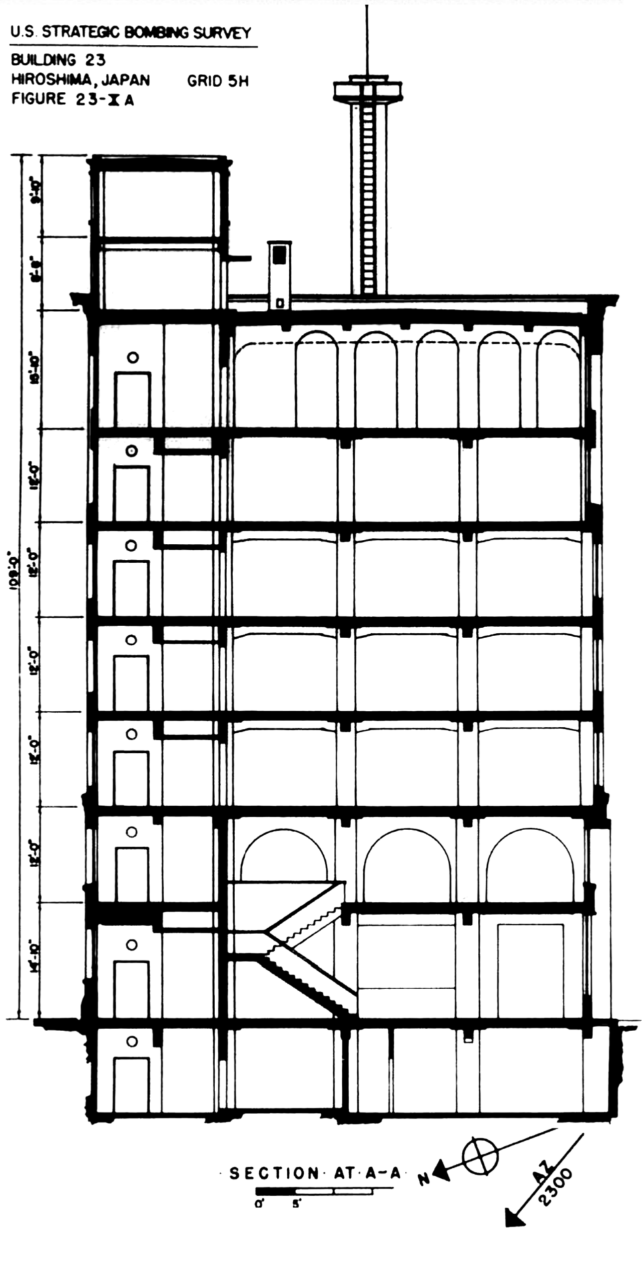
NAME: Fukoku Building.

CONSTRUCTION AND DESIGN

Type: Steel core reinforced-concrete frame.

Number of stories: 7 and basement. JTG class: E1.

Roof: Reinforced-concrete beam and slab (steel core).



# U. S. STRATEGIC BOMBING SURVEY

**PHYSICAL DAMAGE DIVISION**

**Field Team No. 1, Hiroshima, Japan**

**Building No.: 5. Coordinates: 5H. Distance from (GZ): 100, (AZ): 2,000.**

**NAME: Shima Surgical Hospital.**

CONSTRUCTION AND DESIGN

**Type: Bearing wall.**

**Number of stories: 1. JTG class: A 2-3.**

**Roof: Tile over wood on wood truss.**

**Partitions: Plaster on wood lath and studs.**

**Walls: Brick-bearing, 18 inches.**

**Building No.: 6. Coordinates: 5H. Distance from (GZ): 600, (AZ): 2,100.**

**NAME: Chiyoda Life Insurance Co., Chugoku branch.**

CONSTRUCTION AND DESIGN

**Type: Reinforced-concrete frame.**

**Number of stories: Three and basement. JTG class: E1.**

**Roof: Reinforced-concrete beam and slab-tile covered.**

**Partitions: Reinforced-concrete, major—metal lath and plaster, minor.**

**Walls: Reinforced-concrete panels, 10 inches. Reinforced-concrete granite facing.**

# U. S. STRATEGIC BOMBING SURVEY

PHYSICAL DAMAGE DIVISION

Field Team No. 1, Hiroshima, Japan

## BUILDING ANALYSIS

### Sheet No. 1

Building No.: 24. Coordinates: 5H. Distance from (GZ): 1,300, (AZ): 2,400.
NAME: Bank of Japan, Hiroshima branch.
CONSTRUCTION AND DESIGN
Type: Reinforced-concrete frame (steel core).
Number of Stories: 3 and basement. JTG class: E1.
Roof: Reinforced-concrete beam and slab.
Partitions: Reinforced concrete and wood lath.
Walls: Reinforced concrete (12-inch) and stone (6-inch).
Floors: Reinforced concrete.
Framing: Reinforced concrete.
Window and door frames: Metal (exterior) wood (interior). Ceilings: Plaster on concrete.
Condition, workmanship, and materials: Excellent.
Compare with usual United States buildings: Much stronger—steel core construction.
OCCUPANCY: Bank.
CONTENTS: Bank and office equipment furnishings.
DAMAGE to building: Only minor damage—top story burned out, partitions, sash, trim blown out in two lower stories.
Cause: Fire.
To Contents: Destroyed in third story—moderate debris and blast damage in first and second stories, none in basement.
Cause: Fire and debris (about equally).
TOTAL FLOOR AREA (square feet): 32,800. Structural damage: —. Superficial damage:
FRACTION OF DAMAGE: Building structural: —. Superficial: —. Contents: 30 percent.
REMARKS: Glass removed from skylight (20 by 20 feet) and light steel-frame structure and roof covered with 12 to 18 inches of sand and cinders.

Note.—Building damage based on total floor area. Contents damage is fraction of contents seriously damaged.

### Sheet No. 2

(Fire Supplement to Sheet No. 1)

Building No.: 24. Fire classification: R.
WALL OPENINGS: Shutters: Steel rollers.
Shut: Part.
Effect of blast: Blown in.

FLOOR OPENINGS:

| | Enclosed | Fire doors | Automatic | Effect of blast |
|---|---|---|---|---|
| Stairs: | Part | Steel rollers | No | None—doors open. |
| Elevators: | Yes | Metal and W. G. | No | Bent. |

EXPOSURE:

| Location | Distance | Firebreak Clearance | Fire Class | Burned | Remarks |
|---|---|---|---|---|---|
| N | 25′ | No | C | Yes | 14-foot concrete wall between. |
| E | 25′ | No | R | Yes | Building 25 (14-foot wall between). |
| S | — | No | — | — | No exposure. |
| W | 125′ | Yes | C | Yes | |

PROBABLE CAUSE OF FIRE: Fire spread from exposures.
VERTICAL FIRE SPREAD: No.
EXTENT OF FIRE: Total floor area: 32,800 square feet. Floor area burned: 5,200 square feet; 16 percent (after blast damage).

REMARKS: Fire only in room at southwest corner of second story and in entire third story. No fire in building right after bomb, but afire at 1000 hours. Fire in room in second story extinguished with water buckets.

# U. S. STRATEGIC BOMBING SURVEY

**PHYSICAL DAMAGE DIVISION**

**Field Team No. 1, Hiroshima, Japan**

## BUILDING ANALYSIS

### Sheet No. 1

**Building No.:** 59. **Coordinates:** 5I. **Distance from (GZ):** 4,100, **(AZ):** 4,500.

**NAME:** Geibi Bank Co., Hiroshima Branch (in use at time of bomb as the Higashi Police Station).

**CONSTRUCTION AND DESIGN**

**Type:** Reinforced-concrete frame.

**Number of stories:** See sketch. **JTG class:** E1.

**Roof:** Reinforced-concrete beam and slab.

**Partitions:** 7-inch reinforced concrete.

**Walls:** 8-inch reinforced concrete monolithic—medium window.

**Floors:** Reinforced-concrete beam and slab—parquet and tile.

**Framing:** Reinforced-concrete beam and slab.

**Window and door frames:** Steel. **Ceilings:** Sheet metal on wood framing.

Condition, workmanship and materials: Good.

Compare with usual United States buildings: Appreciably stronger than United States design.

**OCCUPANCY:** Police station (office).

**CONTENTS:** Office equipment.

**DAMAGE to building:** Minor damage only—sash blown out and hung ceilings partially stripped.

Cause: Blast.

**To contents:** Slight damage to contents from blast and debris.

Cause: Blast.

**TOTAL FLOOR AREA** (square feet): 16,200. **Structural damage:** —. **Superficial damage:**

**FRACTION OF DAMAGE:** Building. **Structural:** **Superficial:** **Contents:** 10 percent.

**REMARKS:**

Note.—Building damage based on total floor area. Contents damage is fraction of contents seriously damaged.

### Sheet No. 2

(Fire Supplement to Sheet No. 1)

**Building No.:** 59. **Fire classification:** R.

**WALL OPENINGS:** Shutters: Steel rollers in east wall and third story of south and west walls (wired glass in all windows).

Effect of blast: Blown in at west wall, bent at south wall.

**FLOOR OPENINGS:**

| | Enclosed | Fire doors | Automatic | Effect of blast |
|---|---|---|---|---|
| Stairs: | Yes | Metal | No | Bent slightly. |
| Elevators: | | | | |

**EXPOSURE:**

| Location | Distance | Firebreak Clearance | Fire Class | Burned | Remarks |
|---|---|---|---|---|---|
| N | 150′ | Yes | C | Yes | |
| E | 60′ | Yes | C | Yes | |
| S | 30′ | Partial 100′ | C | Yes | All exposures burned. |
| W | 60′ | Yes | C | Yes | |

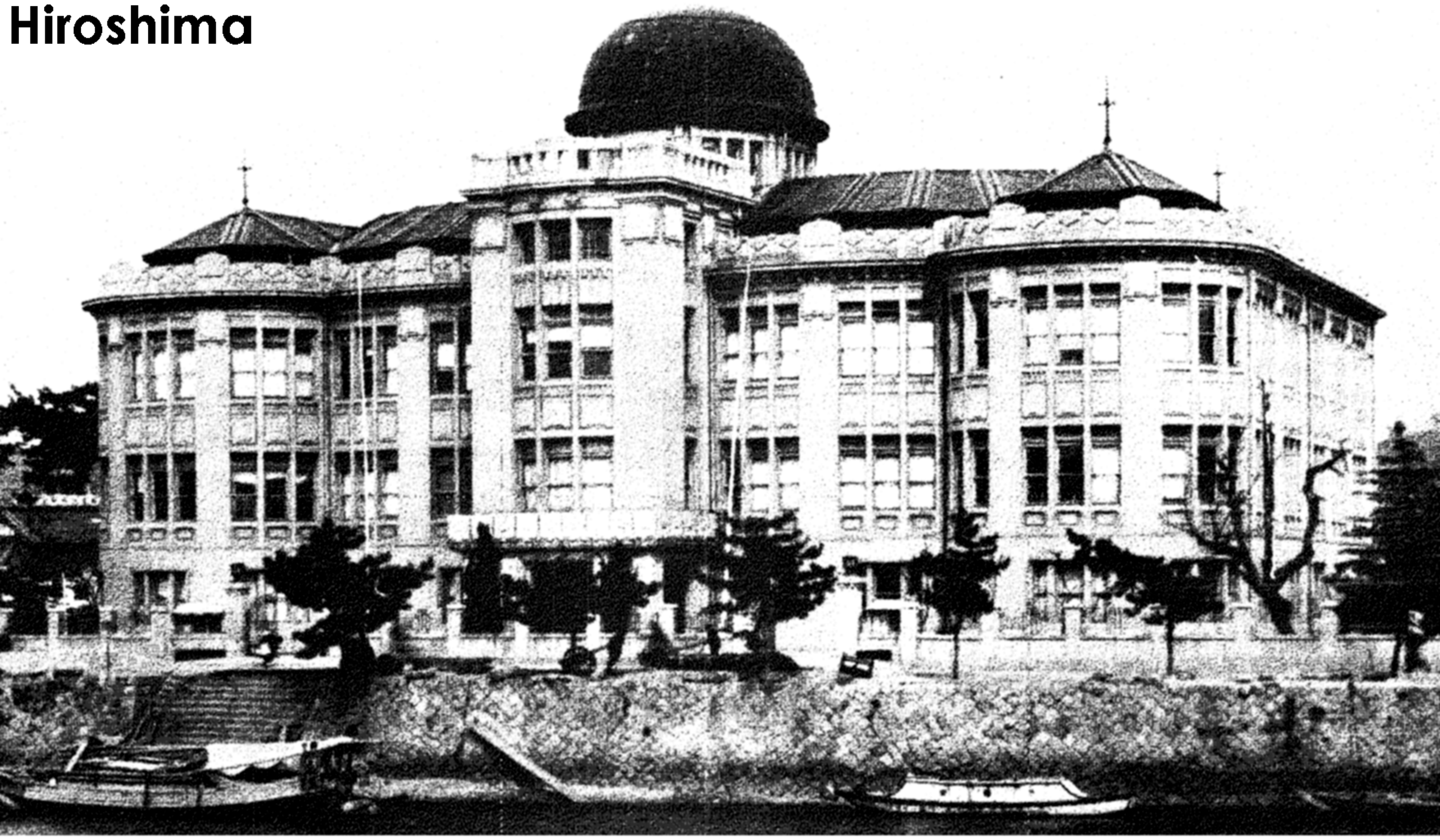
**PROBABLE CAUSE OF FIRE:** Fire spread from exposures.

**VERTICAL FIRE SPREAD:** No.

**EXTENT OF FIRE:** Total floor area: 16,200 square feet. Floor area burned: 0 square feet; 0 percent (after blast damage).

**REMARKS:** Sparks from south exposure ignited few pieces of furniture in first and third stories and cotton blackout curtains in first story about 1030 hours. Fires were extinguished with water buckets by people inside. Negligible fire damage resulted. Some of exposing buildings had just been removed prior to the bomb.

Hiroshima



Commercial Museum ('300 meters) before and after

BANK OF JAPAN BUILDING AFTER ATTACK ON HIROSHIMA

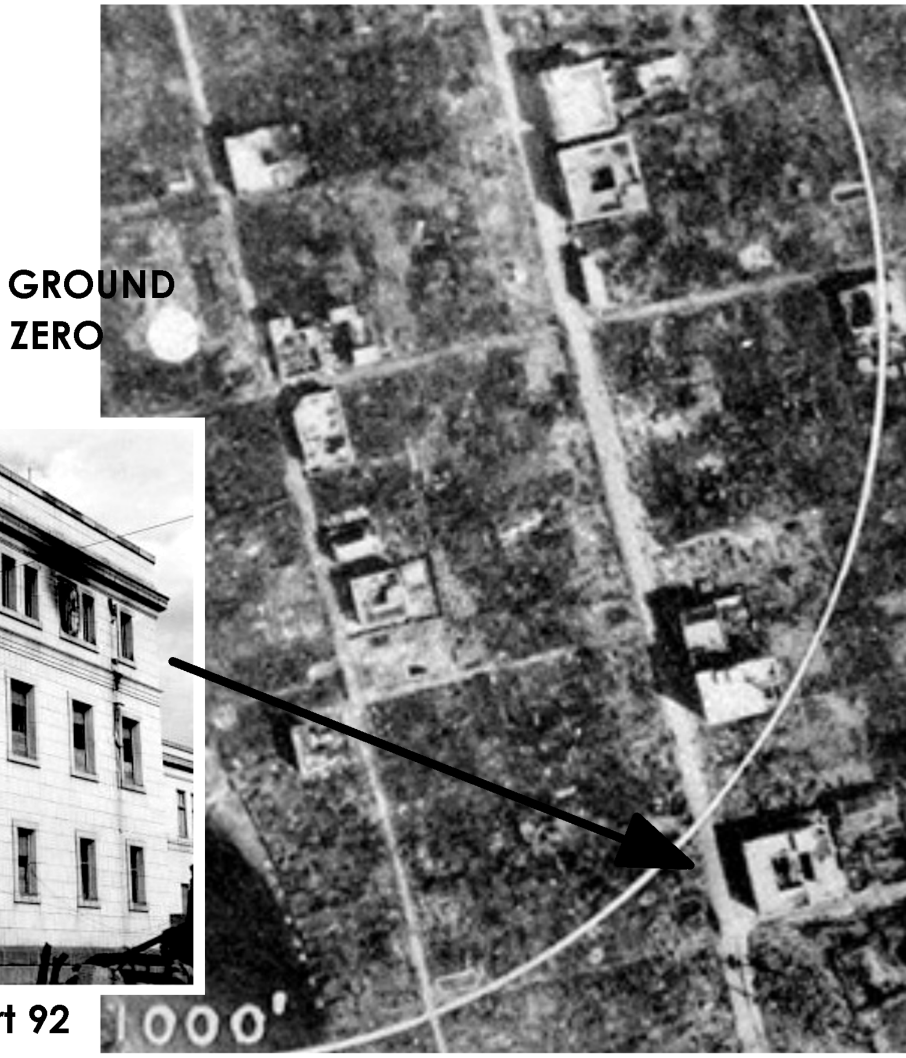
GEIBI BANK CO. BUILDING AFTER ATTACK ON HIROSHIMA

**Bank of Japan: USSBS Building 24, 1300 ft from GZ**
**Geibi Bank Co: USSBS Building 59, 4100 ft from GZ**
**(Table 5 of USSBS report 92 Hiroshima, v2.)**

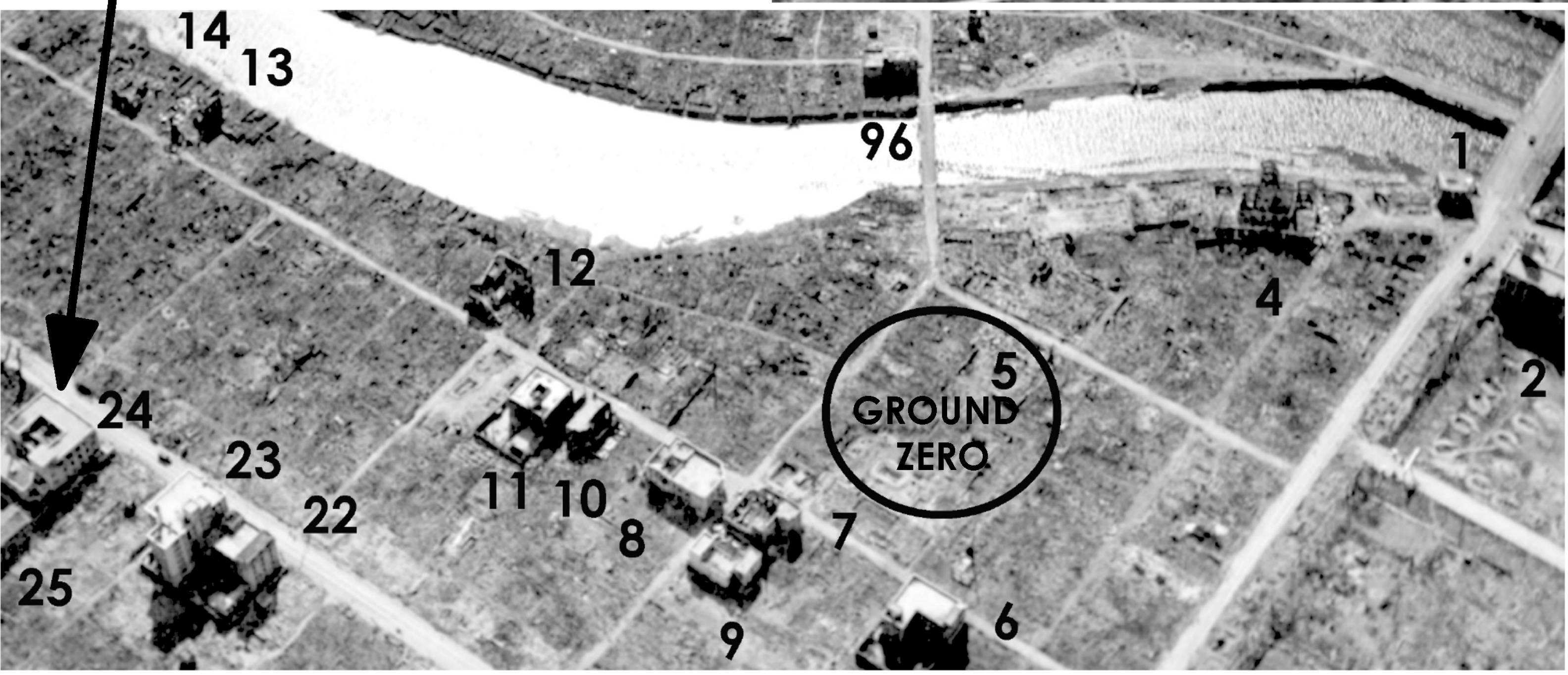
**In both, survivors extinguished fire with water buckets.**

**(Ref: Panel 26 of the "DCPA Attack Environment Manual", Chapter 3.)**

Building No.: 24. Coordinates: 5H. Distance from (GZ): 1,300, (AZ): 2,400.
NAME: Bank of Japan, Hiroshima branch.
CONSTRUCTION AND DESIGN
Type: Reinforced-concrete frame (steel core).
Walls: Reinforced concrete (12-inch) and stone (6-inch).
Floors: Reinforced concrete.
Framing: Reinforced concrete.
REMARKS: Fire only in room at southwest corner of second story and in entire third story. No fire in building right after bomb, but afire at 1000 hours. Fire in room in second story extinguished with water buckets.




U.S. Strategic Bombing Survey report 92



## Secondary Fires

Secondary fires are those that result from airblast damage. Their causes include overturned gas appliances, broken gas lines, and electrical short-circuits. McAuliffe and Moll (Reference 1 ) studied secondary fires resulting from the atomic attacks on Hiroshima and Nagasaki and compared their results with data from conventional bombings, explosive disasters, earthquakes, and tornadoes. Their major conclusion was that secondary ignitions occur with an overall average frequency of 0.006 for each 1000 square feet of floor space, provided airblast peak overpressure is at least 2 psi. The frequency of secondary ignitions appears to be relatively insensitive to higher overpressures.

Based on surveys of Hiroshima and Nagasaki buildings.

**FREQUENCY OF SECONDARY IGNITIONS AS A FUNCTION OF BUILDING TYPE**

| Type of Structure | Frequency of Secondary Ignitions (for each 1,000 square feet of floor area) |
|---|---|
| Wood | 0.019 |
| Brick | 0.017 |
| Steel | 0.004 |
| Concrete | 0.002 |

**MULTIPLYING FACTOR FOR TYPES OF BUILDING OCCUPANCIES**

| Type of Occupancy | Multiplying Factor |
|---|---|
| Public | 0.4 |
| Mercantile | 0.5 |
| Residential | 0.5 |
| Manufacturing | 1.0 |
| Miscellaneous | 10.0 |

**MULTIPLYING FACTOR FOR TIME OF DAY**

| Time of Day | Multiplying Factor |
|---|---|
| Night | 0.5 |
| Day (other than mealtimes) | 1.0 |
| Mealtimes | 2.0 |

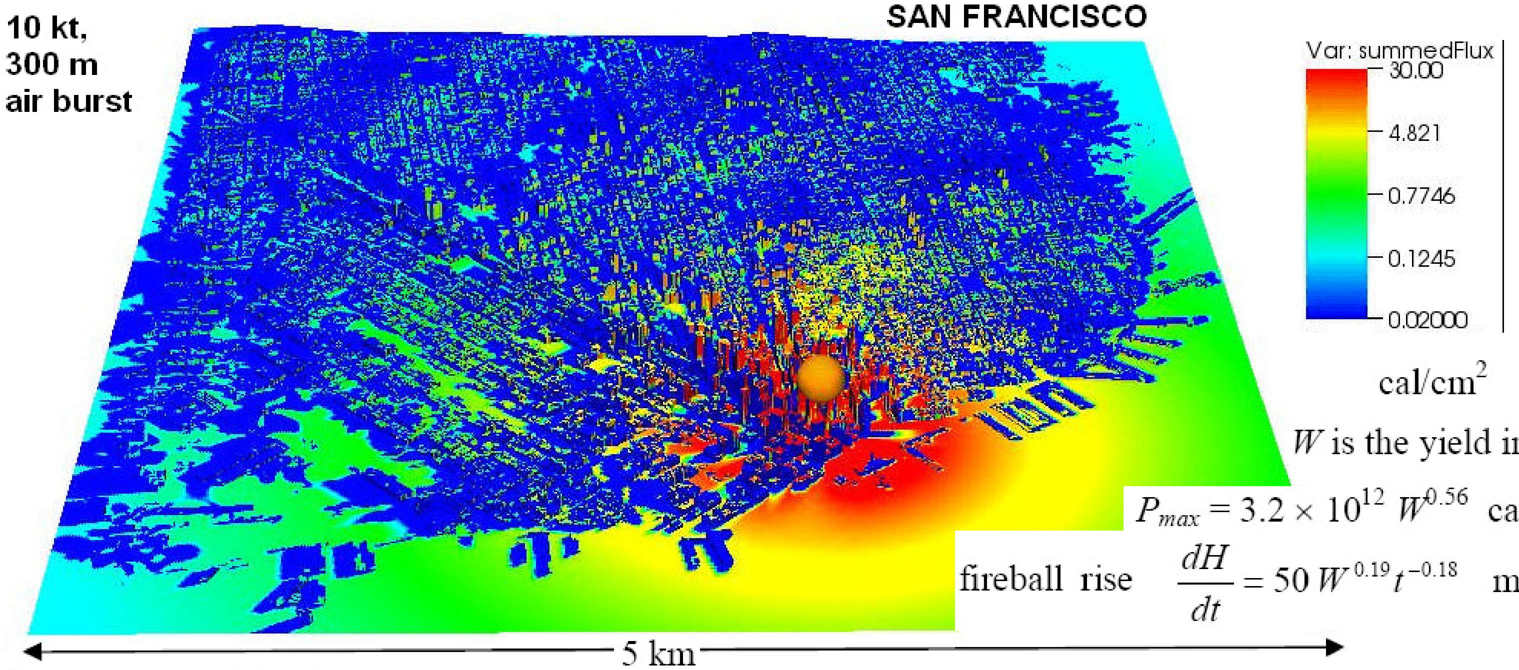
1 . Secondary Ignitions in Nuclear Attack, J. McAuliffe and K. Moll, Stanford Research Institute, Menlo Park, California 94025, SRI Project 5106 (AD 625173), July 1965.

# Thermal Radiation from Nuclear Detonations in Urban Environments


R. E. Marrs, W. C. Moss, and B. Whitlock
Lawrence Livermore National Laboratory



UCRL-TR-231593
June 7, 2007

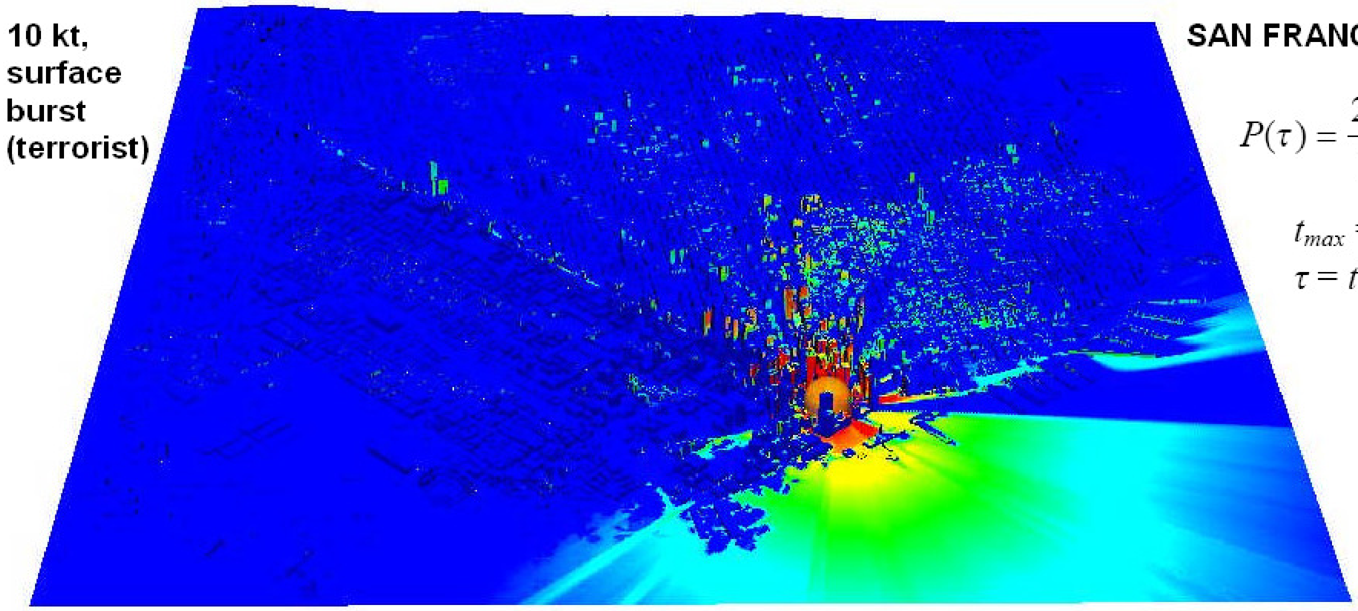




cal/cm$^2$

$W$ is the yield in kt

$$P_{max} = 3.2 \times 10^{12}\ W^{0.56} \quad \text{cal/s}$$

fireball rise $$\frac{dH}{dt} = 50\ W^{0.19} t^{-0.18} \quad \text{m/s}$$



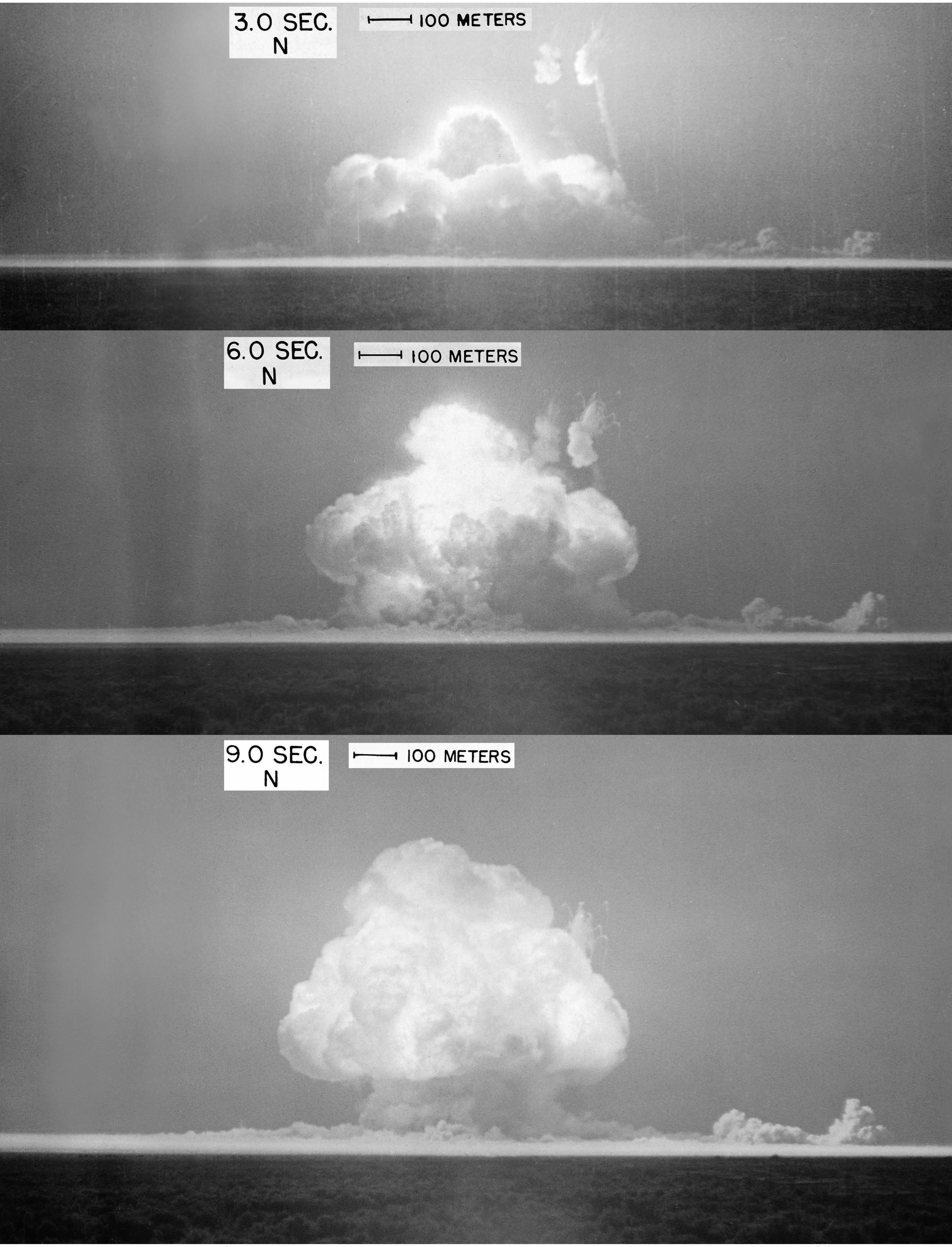

$$P(\tau) = \frac{2.85(\tau + 0.5)^{-2}}{1 + e^{-(\tau - 0.8)/0.15}}$$

$$t_{max} = 0.04\ W^{0.44} \quad \text{s}$$

$$\tau = t \,/\, t_{max}$$

Even without shadowing, the location of most of the urban population within buildings causes a substantial reduction in casualties compared to the unshielded estimates. Other investigators have estimated that the reduction in burn injuries may be greater than 90% due to shadowing and the indoor location of most of the population [6].

We have shown that common estimates of weapon effects that calculate a "radius" for thermal radiation are clearly misleading for surface bursts in urban environments. In many cases only a few unshadowed vertical surfaces, a small fraction of the area within a thermal damage radius, receive the expected heat flux.




**TRINITY (19 kilotons, 100 feet burst altitude, New Mexico, 16 July 1945). Note the very slow rate of fireball rise.**

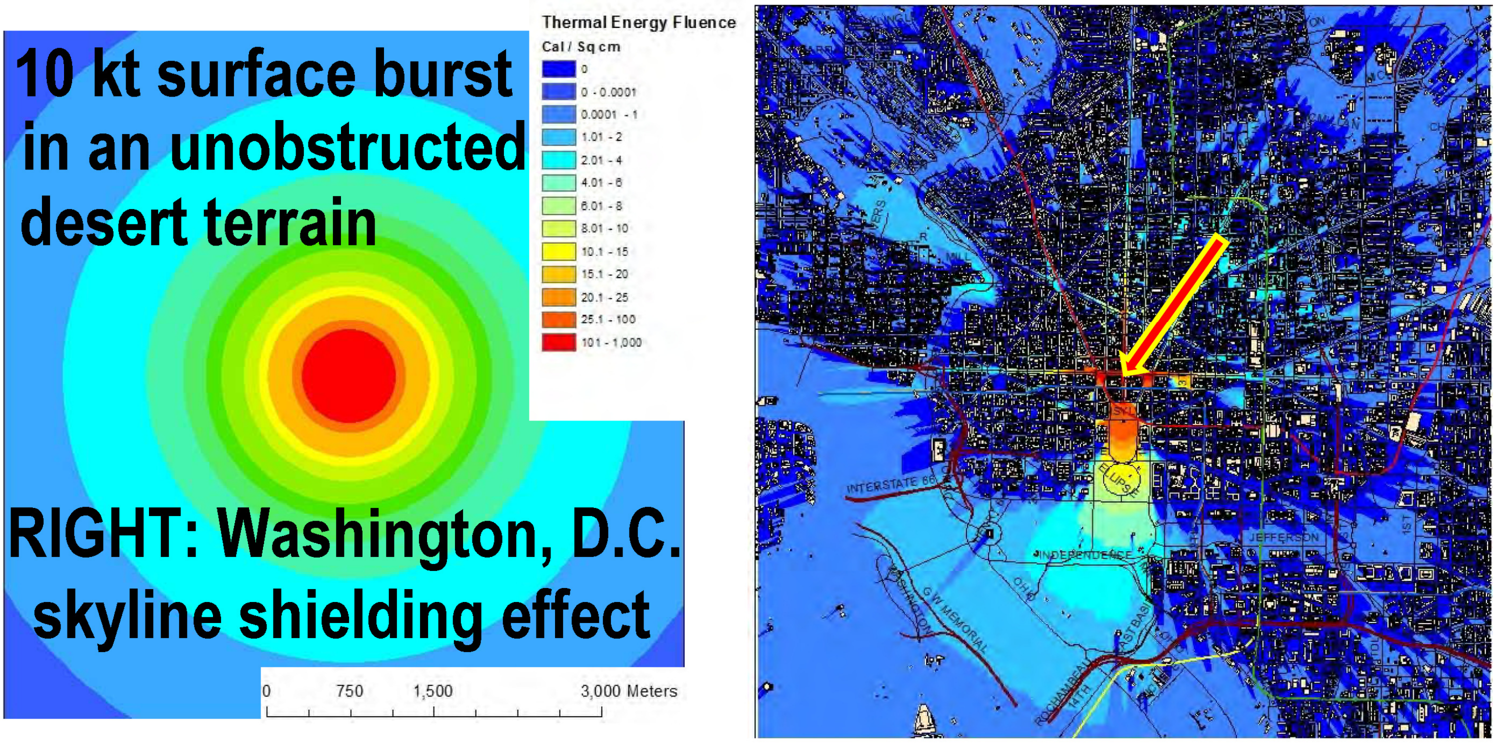
# *Modeling the Effects of Nuclear Weapons in an Urban Setting*

**Radiation Countermeasures Symposium**
**An AFRRI 50th Anniversary Event**

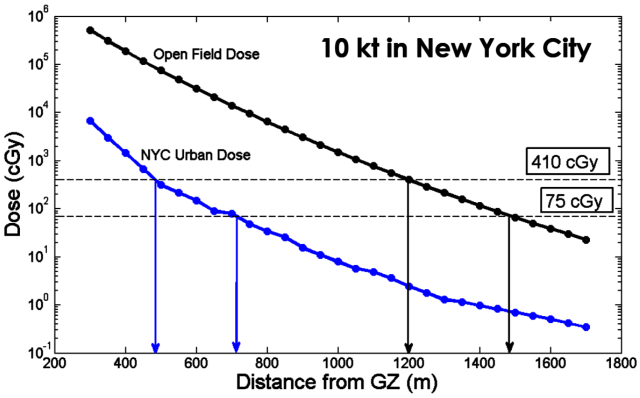

***Kyle Millage, CHP, PE***
***Applied Research Associates, Inc.***

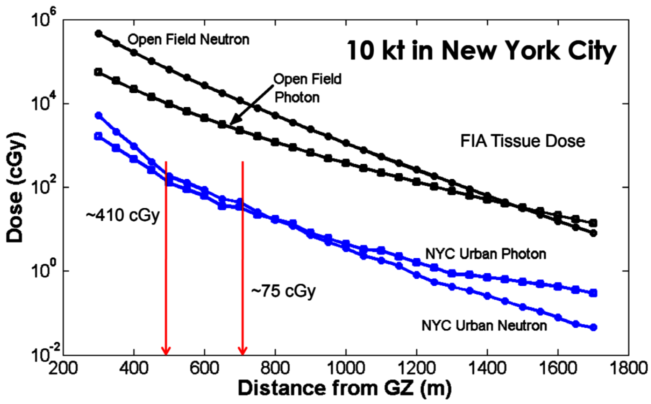

***15 June 2011***

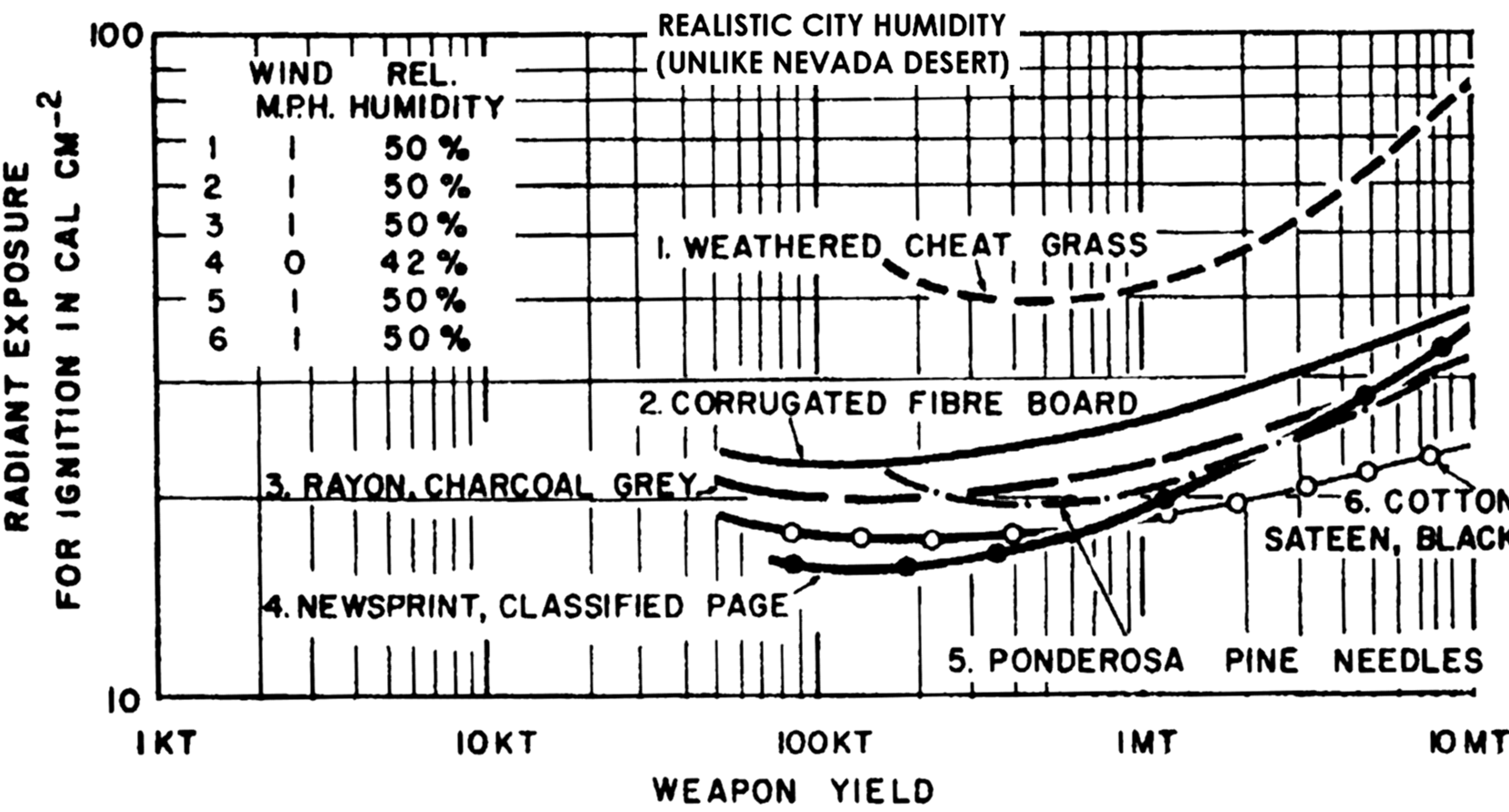





- Classic prompt circles of blast, thermal and radiation environments in an open field will significantly over-estimate the effects in an urban setting






"TECHNICAL OBJECTIVE AW-7, CRITICAL RADIANT EXPOSURES FOR PERSISTENT IGNITION", JULY 1960, J. BRACCIAVENTI & F. DEBOLD AD-249476; DASA-1194

UCRL-TR-231593

**Thermal radiation from nuclear detonations in urban environments**

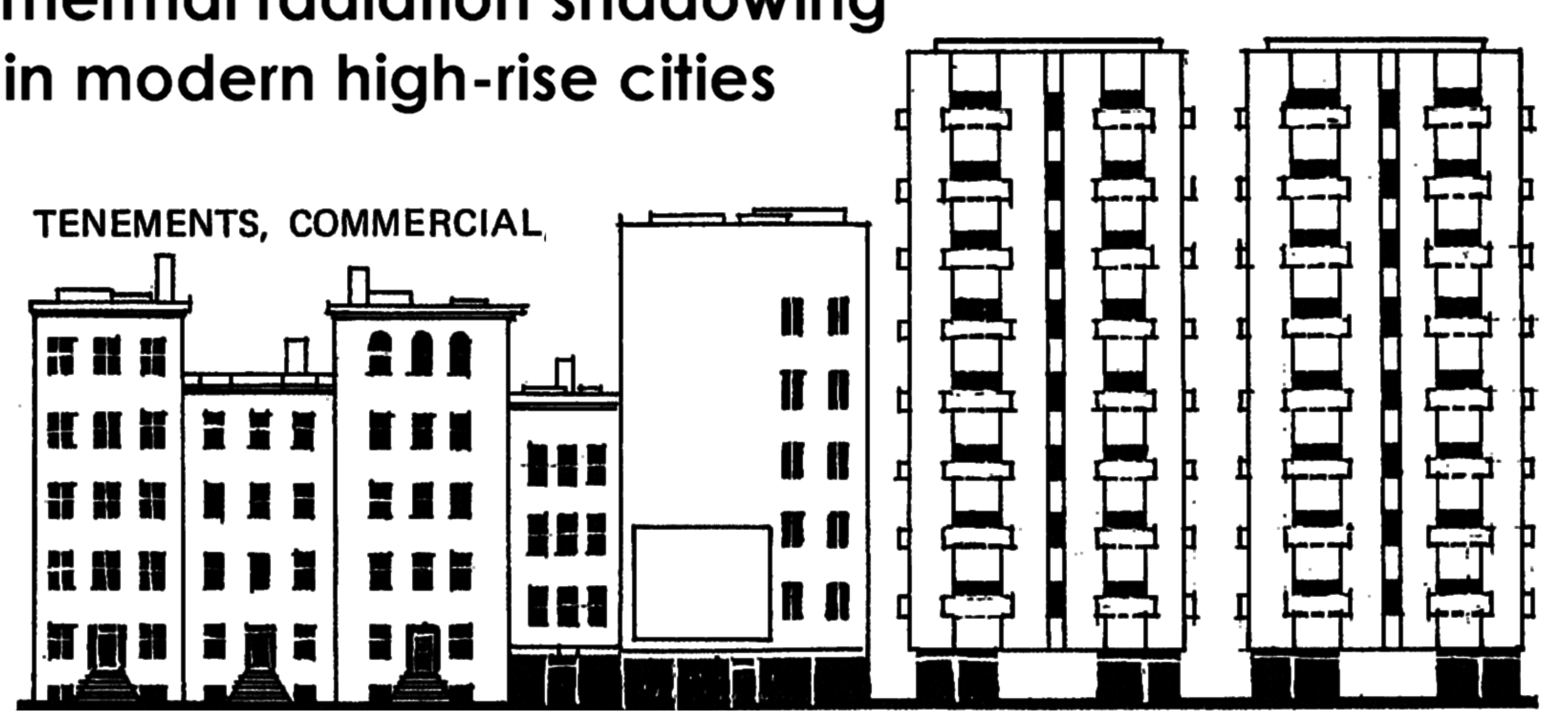
LAWRENCE LIVERMORE NATIONAL LABORATORY

June 7, 2007

Even without shadowing, the location of most of the urban population within buildings causes a substantial reduction in casualties compared to the unshielded estimates. Other investigators have estimated that the reduction in burn injuries may be greater than 90% due to shadowing and the indoor location of most of the population [6].

We have shown that common estimates of weapon effects that calculate a "radius" for thermal radiation are clearly misleading for surface bursts in urban environments. In many cases only a few unshadowed vertical surfaces, a small fraction of the area within a thermal damage radius, receive the expected heat flux.

# Thermal radiation shadowing in modern high-rise cities




Folded newspapers may not take fire, but loosely crumpled ones will. The answer? Get rid of trash.

A wet mop or broom will snuff out small fires. So will a burlap bag or a small rug soaked in water.

Buckets of water and sand are essential.

Water is an effective fire fighting agent because it smothers and cools at the same time.

## Feasibility

In the typical household, some materials will generally be available for covering windows against thermal radiation. One half roll of aluminum foil would cover about 25 $ft^2$ and would provide very effective covering for 1 to 2 windows (those most likely to face the blast). Sufficient quantities of either light colored paint, Bon Ami, or whiting would be available in most households to cover windows. Aluminum screens attenuate from 30 - 50% of the thermal radiation and hence screens should be closed or installed.

The amount of water per square foot required to dissipate 25 $cal/cm^2$ of thermal radiation can quickly be calculated from the heat of vaporization of water (580 cal/gm). Allowing 90% losses due to absorption or spillage, one gallon of water is sufficient to wet 10 $ft^2$ of material so that it can withstand 25 $cal/cm^2$ of direct thermal radiation (i.e., the radiation is normal to the material surface at all points). Since the average daily water consumption per service (Reference 3) is about 700 gallons, it is apparent that the wetting of interior flammables (piled up curtains, furniture, etc.) is feasible in most cases when used in conjunction with the other measures.

3. Statistical Abstracts of the United States. Washington: U. S. Government Printing Office, 1962.

NOTE: discrepancies are due to HUMIDITY differences.
ENCORE nuclear test (Nevada desert) humidity was ONLY 19%

ADA383988

Table B-VII

COMPARISON OF ESTIMATES FOR IGNITION ENERGY REQUIREMENTS
(10 mt)

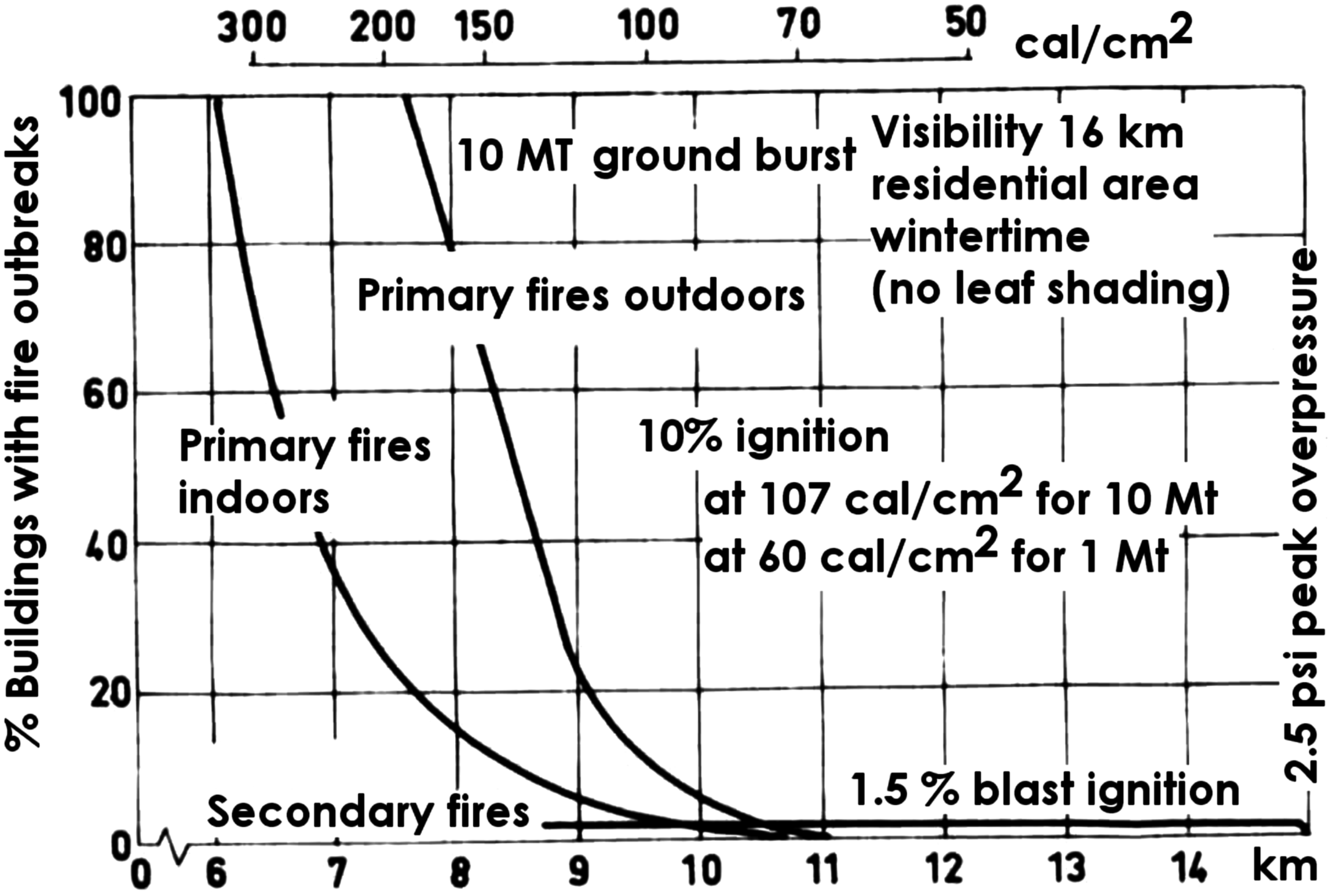
| Glasstone (1962) The Effects of Nuclear Weapons | | Martin, et al. (1959) Naval Radiological Defense Laboratory | | |
|---|---|---|---|---|
| Material | Cal/cm$^2$ for Ignition | Material | Cal/cm$^2$ for Ignition | Ratio of NRDL to ENW |
| Cotton auto seat upholstery, green, brown, white | 16 | Heavy cotton draperies, dark color | 28 | 1.75 |
| Wool pile chair upholstery, wine | 35 (not sustained) | Wool pile chair upholstery, dark color | 25 | 0.7 |
| Newspaper, single sheet | 6 | Newspaper, medium printed | 40 | 6.7 |
| | | Newspaper, dark areas | 30 | 5. |
| Kraft paper carton, flat side exposed, used, brown | 15 | Corrugated Kraft board | 40 | 2.6 |
| Deciduous leaves | 12 | Walnut leaves | 54 | 4.5 |
| | | Beech leaves | 36 | 3. |
| Coarse grass | 16 | Harding grass | 44 | 2.7 |
| Ponderosa pine needles, brown | 18 | Pine needles | 50 | 2.7 |

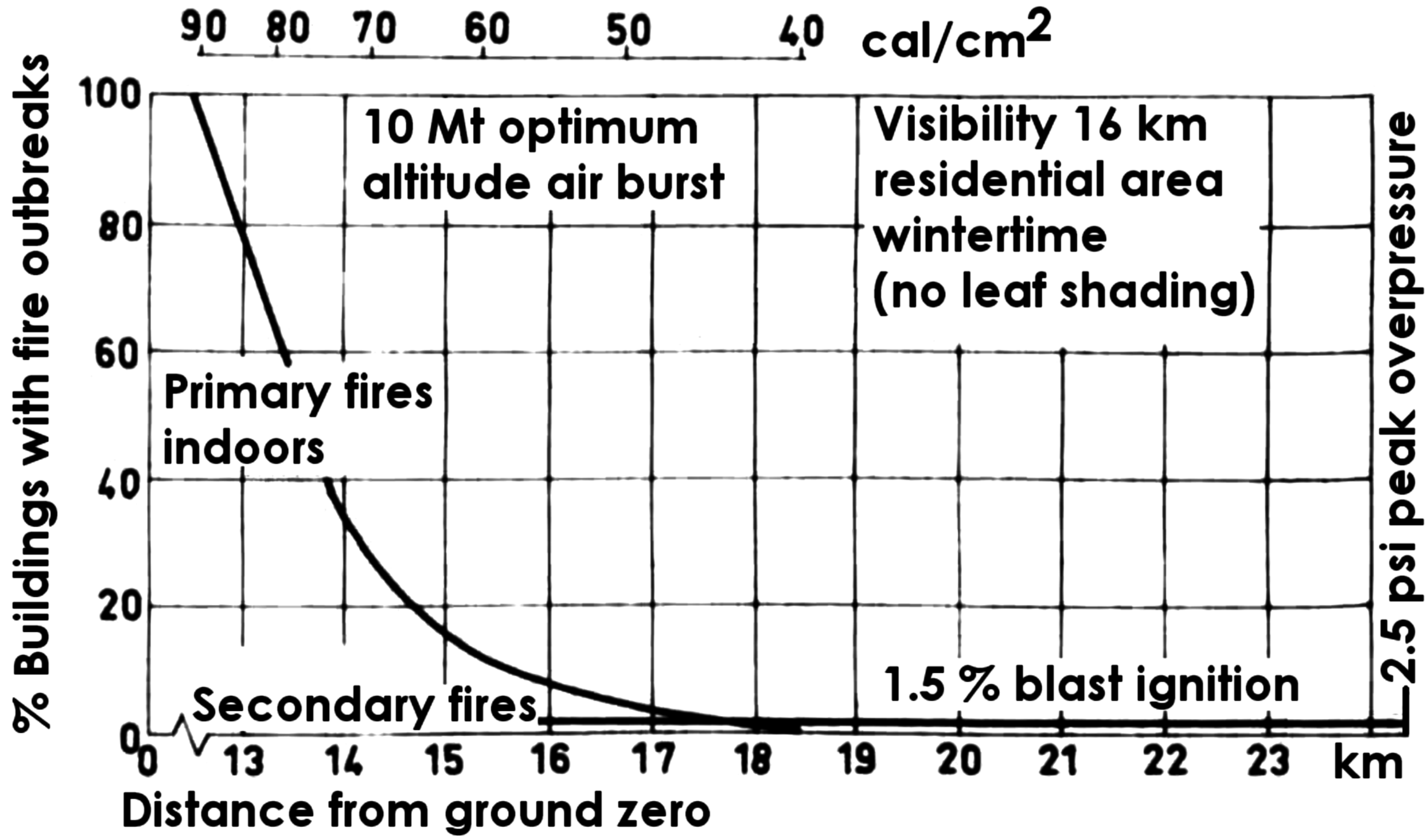
Sources: Martin, et al. (1959) and Glasstone (1962).

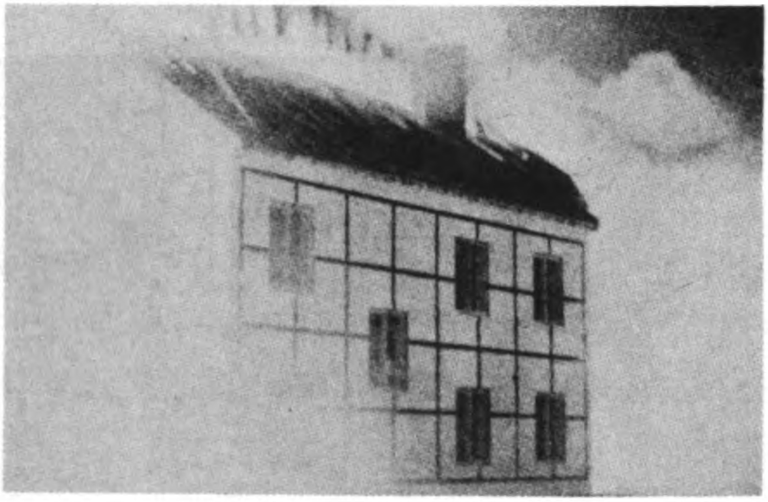


Martin, S. B., On Predicting the Ignition Susceptibility of Typical Kindling Fuels to Ignition by the Thermal Radiation from Nuclear Detonations, Tech. Report 367, U.S. Naval Radiological Defense Laboratory, San Francisco, Calif., April 1959. (U)

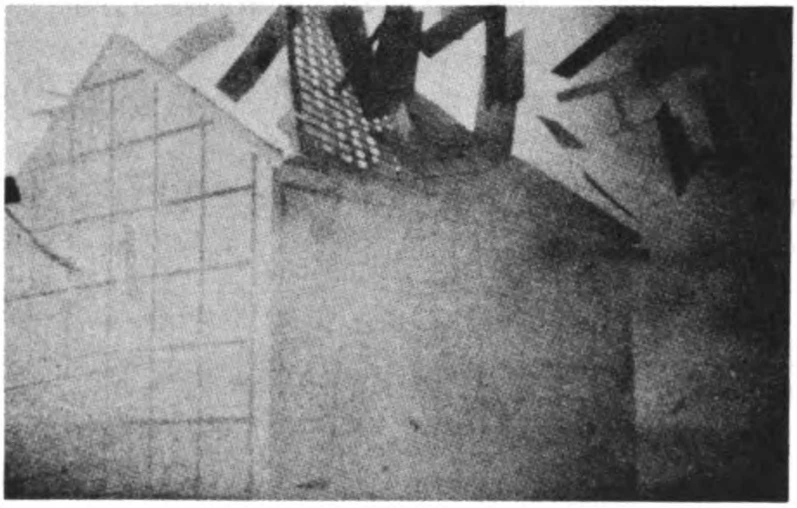
John L. Crain, et al., Supplemental Analysis - Civil Defense Rescue, Stanford Research Institute, AD0625802, 1965.



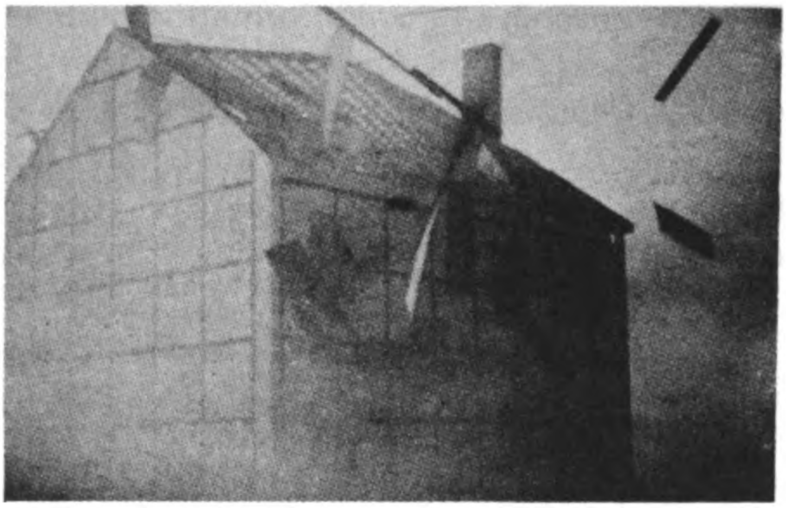





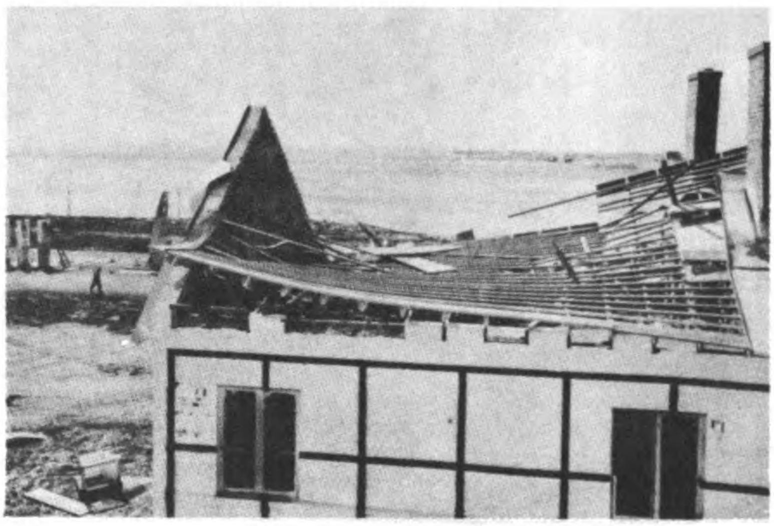
# 47 kt Greenhouse Easy, Eniwetok Atoll, 1951. Brick house, 3 psi peak overpressure



0.6 second



Impact + 1.0 second



Afterward

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We have all had the frustrating experience of trying to light a fire with green, moist, or wet wood. Just as wet wood can't be easily induced to burn, so thick combustibles are not easily ignited. Even a dry two-by-four burns reluctantly and stops burning when taken out of the fire. It is a different matter with a shingle or a bunch of kindling! Density also plays a role, a heavier combustible being harder to ignite than lighter-weight material. Of course, the chemistry of the material to the degree that it influences kindling temperatures and flammability, is an important parameter. Modern plastics tend to smoke and boil - to ablate but not to ignite in sustained burning - while paper trash burns readily.

---

Just as most materials are not particularly sensitive to the sun's thermal radiation, and are not highly inflammable nor even ignitible, the surfaces exposed to the thermal intensity of a nuclear explosion are generally not given to sustained burning. Very intense heat loads may mar or melt surfaces, may char and burn surfaces while the heat is on, but may snuff out immediately afterward.

---



## PRIMARY AND SECONDARY FIRES FROM NUCLEAR EXPLOSIONS

Although thermal radiation would start many fires in urban and in most suburban areas, such fires by themselves would seldom constitute a source of major destruction. Outside the region of extensive blast damage, fires in trash piles, in dry palm trunks, in roof shingles, in auto and household upholstery, drapes, or flammable stores are normally accessible and readily controllable. By the very fact that these fires start from material exposed to the incident light, they can be easily spotted and, in the absence of other distractions, can be quickly extinguished. Where the blast effects are severe and damage extensive, little effective fire fighting is likely.

**A SURVEY OF THE WEAPONS AND HAZARDS WHICH MAY FACE THE PEOPLE OF THE UNITED STATES IN WARTIME**

Harold L. Brode

P-3170

June 1965



Most exposed surfaces in the city are non-combustible and much of the remainder is not ignitable by thermal flash. Although many fires could simultaneously start wherever building interiors are illuminated by the bomb thermal energy, they are not likely to be immediately beyond control, and will often go out unattended as they exhaust the available fuel (as in trash barrels or isolated wood piles or even pieces of paper on tables or floors).

Hanging non-flammable shields over window openings and removing likely fuels from exposed positions could also help.

RAND CORPORATION

CONFIDENTIAL

WT-774

Copy No. 186 A

# Operation
# UPSHOT-KNOTHOLE

## NEVADA PROVING GROUNDS

March - June 1953

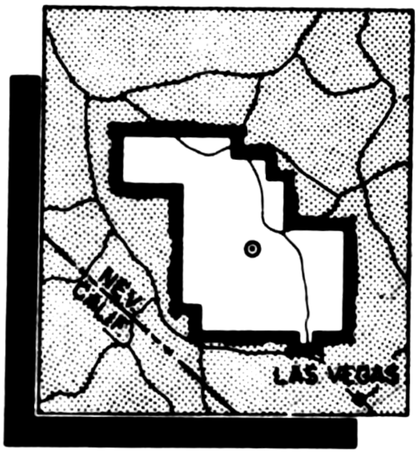
Project 8.11a

**INCENDIARY EFFECTS ON BUILDING AND INTERIOR KINDLING FUELS**

## (ENCORE EFFECT REPORT)

27 kt at 2,423 feet altitude, 19% humidity

(DASA-1251) (Note: cities humidity is ~50-80%)




**RESTRICTED DATA**

This document contains restricted data as defined in the Atomic Energy Act of 1946. Its transmittal or the disclosure of its contents in any manner to an unauthorized person is prohibited.

HEADQUARTERS FIELD COMMAND, ARMED FORCES SPECIAL WEAPONS PROJECT
SANDIA BASE, ALBUQUERQUE, NEW MEXICO

CONFIDENTIAL

**Weapon test report WT-774, Project 8.11a, Incendiary effects on buildings and interior kindling fuels**

ENCORE test, Nevada, 1953
10' x 12' wooden houses with 4' x 6' windows
17 calories/sq. cm thermal flash

Immediate room flashover during thermal pulse
("Encore effect") in inflammables-filled house
while fire-resistant fabrics in other house survived!

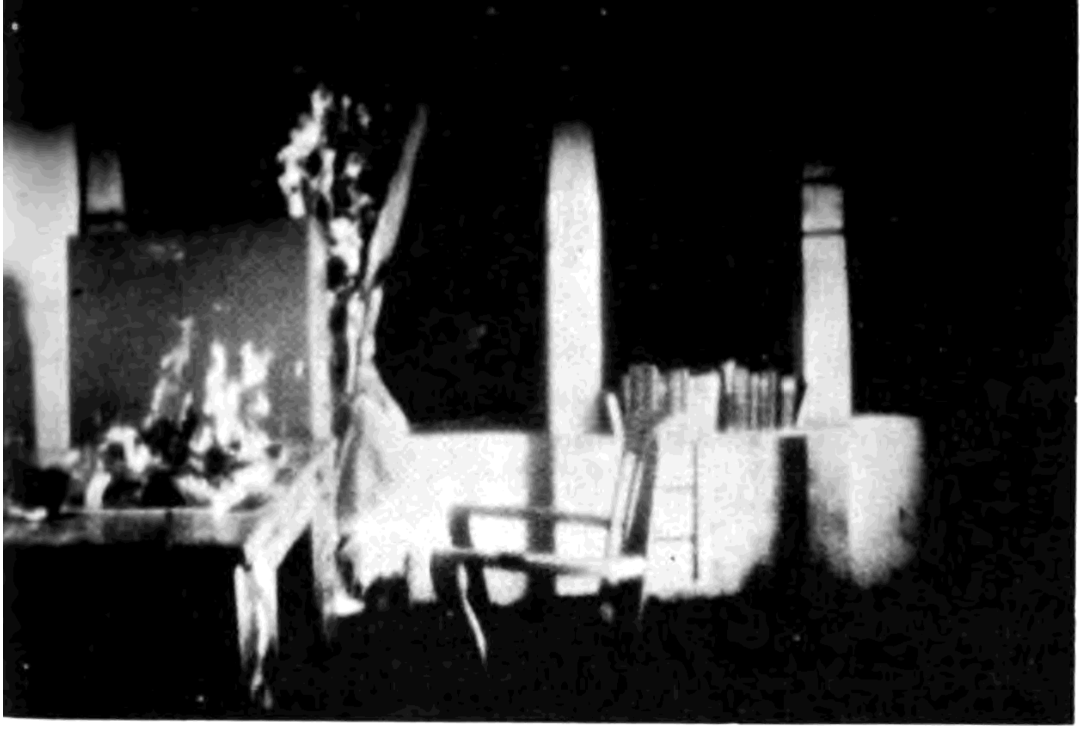

LEFT HOUSE: fire-resistant furnishings
(woolen rugs and clothes, vinyl plastic draperies)

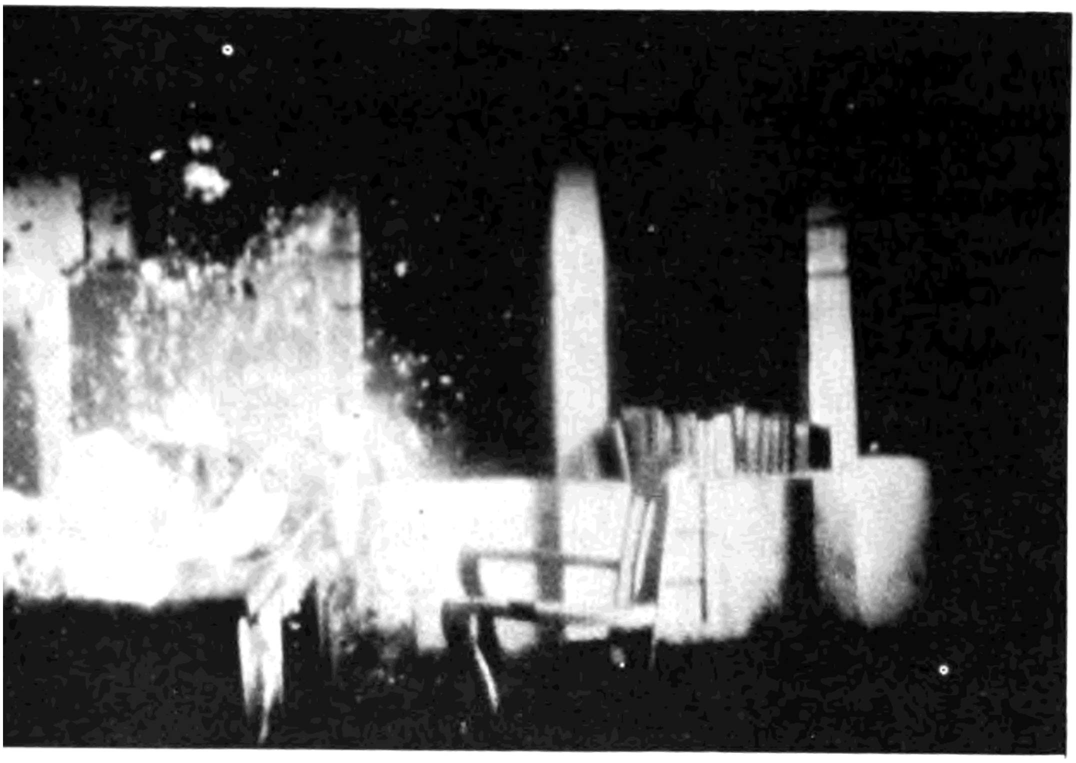

RIGHT HOUSE: non-fire resistant furnishings
plus inflammable magazines and newspapers

Smouldering armchair extinguished 1 hour after detonation, when recovery party arrived at house

**EFFECTS OF 1 PSI OVERPRESSURE ON IGNITIONS**

From: Goodale, Effects of Air Blast on Urban Fires
URS 7009–14 Dec. 1970
(AD 723 429)





**Blast winds both cool burning material and upset flame convection system.**

**50% of burning curtains are extinguished by 1 psi overpressure**

**100% are put out by 2.5 psi. Note that burning LIQUIDS in high-wall trays are not put out by blast waves, but this is not relevant to city fires.**

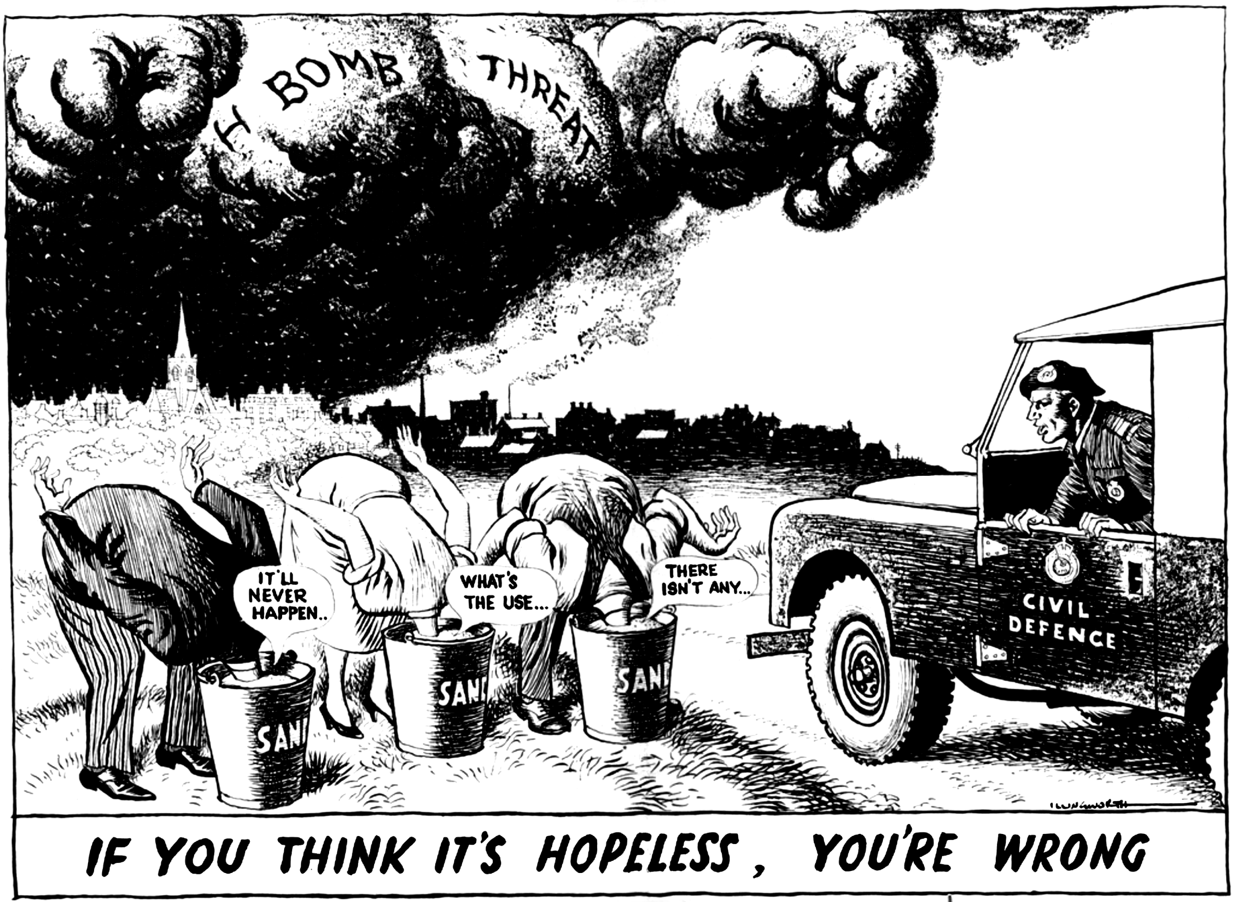
**Burning beds can continue to smoulder until extinguished with water.**

HUMIDITY HAS LESS INFLUENCE ON FINE
KINDLING IGNITION ENERGY
THAN ON WOOD IGNITION

THERMAL PULSE
DRIES LEAVES/PAPER

THERMAL PULSE CANNOT
PENETRATE 1 MM OF WOOD

THERMAL PULSE IS TOO BRIEF
TO DRY OUT WOOD




*Specially drawn for H.M. Government by Illingworth*

Cartoon by Leslie Illingworth

## FOUR STRAIGHTFORWARD SIMPLE FACTS ABOUT

# Civil Defence Today

*The basic minimum of information for every responsible man and woman*

**1 The H-Bomb: we hear too much of the horrors, not enough about our chances of survival.** Some people will tell you that if this country were attacked with H-Bombs, every man jack of the population would be wiped out. ***That just isn't true: it isn't anything LIKE the truth.***

There would be terrible devastation, but for millions and millions of people, chances of survival would be very good. It depends very much on our Civil Defence. The more people we have in it, the better.

**2 Civil Defence is well on with the job already.** Some people think of Civil Defence equipment as a long-handled shovel, a rather odd tin hat, and so on.

Well, it's not like that at all. Civil Defence today is a modern, country-wide Service, which offers you training with first-class equipment—radio and radiation-testing instruments, fire-fighting apparatus and rescue gear, and the latest four-wheel-drive vehicles. There are thousands of qualified Instructors, three full-time Instructors' Schools, and a Staff College for advanced courses and studies.

The more you get to know about Civil Defence, the more impressed you become.

There is a Civil Defence organisation in every town in the Kingdom, and there are units in thousands of industrial firms. There are *half a million* people in the Civil Defence Services today. But half a million is not enough: not nearly.

**3 Civil Defence is useful to you now, in peace.** In Civil Defence today, you *learn*. That is the whole aim and object of joining.

You learn, first and foremost, how to live with your eyes open in the same world as the H-Bomb. You begin to learn what this new, nuclear-age world is really like. You acquire a fuller, deeper understanding of many important events that we are all involved in, whether we like it or not.

Besides this, there is a practical, everyday value in the things you learn. Take just one part of it—First Aid. In Great Britain in 1956 there were over *a quarter of a million* casualties from motor accidents, and probably at least another *million* casualties from accidents in the home. What you know—or don't know—about First Aid could make all the difference to somebody.

Do you know how to put out a fire? Do you know how to operate a radio transmitter? These are two more of the useful, interesting things that Civil Defence could teach you, now.

Do you remember the East Coast floods, the Lynmouth disaster, the Harrow rail smash? These are three of the emergencies where trained volunteers from Civil Defence were ready and able to help. They were needed.

**4 Civil Defence wants more volunteers, NOW.** It's no good saying "I'll be there on the day." That's too late. There wouldn't be time to train you and organise you.

It's no good leaving Civil Defence to other people. For everybody else, *The Other Fellow is YOU.*

You live in this world, you are part of the nuclear-age—there is no opting-out for anybody. Civil Defence *matters*—and matters to YOU.

Go along to your Council Offices today, and ask about Civil Defence. There's no commitment, no 'bull', no length-of-service engagements.

Your training takes only about *one hour a week*. The classes are free, and are near your own home. The knowledge you gain could be useful to you at any time, and would be VITAL to you if we were at War.

Civil Defence is sound common sense. It's high time you were in it.

Warden Section

Headquarters Section

Ambulance and Casualty Collecting Section

Welfare Section

## The FOURTH Arm

Traditionally, we have three Services in this country: the Royal Navy, the Army, and the Royal Air Force. Now, we have a fourth service of the Crown—unarmed, volunteer, part-time—but not less vital than the others: Civil Defence. We have peacetime Civil Defence for just the same reasons that we have a peacetime Navy, Army and Air Force: it is an essential part of our ordinary peacetime national preparedness. *That is all there is to it.*

### WHAT YOU CAN DO IN CIVIL DEFENCE

## Five Sections: *which will you join?*

**WARDEN.** This is a job for a man or woman with a quick, cool head and the power of leadership—and something of a flair for getting on with people. The Warden takes control of the area in an emergency and directs the other services where they are required.

**HEADQUARTERS.** This is the nerve-centre, where the reports come in and the orders go out. If you are an office or scientific worker, a radio 'ham', motor-cyclist or driver—here is interesting, important work that you could train for now.

**RESCUE.** Members of Rescue Squads are highly skilled. Each man carries a pack containing saw, wrecking-bar, lashings, wire-cutters and First Aid kit—and he is trained in the use of all of them. Backing up the Rescue Squad is a special Rescue Vehicle, with scaffold-poles, cables, winches, stretchers and heavy rescue gear. A rescue man needs intelligence as well as strength.

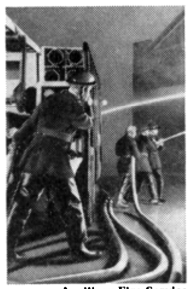
The **AMBULANCE AND CASUALTY COLLECTING** Section want two sorts of people—casualty collectors, to give First Aid and see that the injured get back safely to the ambulances—and drivers to take the ambulances back to hospital. This is work for both men and women—and if you drive a car already, so much the better.

The **WELFARE** Section would be called on first to help in bringing care and comfort to some millions of evacuees. But that is only the beginning of their job. After an attack, there would be more millions of people, to be housed, clothed, fed and kept healthy. Our very survival could depend on what the Welfare Section did then. The Welfare Section needs dependable, intelligent, capable men and women; and it needs them now.

**AND THE AUXILIARY FIRE SERVICE, which also has really worth-while, practical training to offer. The work is important; a nuclear explosion sends out an intense heat-wave, and fires would be numerous and quick to spread. The A.F.S. has special nuclear-war fire-fighting apparatus: you would do your training with it.**

**IN EVERY SECTION YOU GET FIRST AID TRAINING**

Rescue Section



Auxiliary Fire Service

*Civil Defence Recruiting Drives are going on now, all over the country. Their object is to tell you all about Civil Defence — what it can do, what it IS doing and what there is in it for you.*

**CIVIL DEFENCE is common sense**

*Go to your Council Offices and ask, today. They will be glad to see you.*

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UK National Archives: INF 2/122 September 1957 national press advert

COPY No. 15
14 PAGES

AWRE – T1/53

[redacted]

[redacted]

Wd. 22/10/84. SCO 468 refers

NATIONAL ARCHIVES
ES5/1

MINISTRY OF SUPPLY

# ATOMIC WEAPONS RESEARCH ESTABLISHMENT

## REPORT No. T 1/53
(HURRICANE)

B.0134





A.W.R.E.
Aldermaston Berks.

[redacted]

May, 1953

## 3.2 Blast Damage

Outdoor peak overpressure was 51 psi at 500 yds,
25 psi at 665 yds and 10 psi at 1,000 yds
3 psi extended to 2,000 yds

### 3.2.1 Anderson Shelters

Standard Anderson Shelters, with sandbag covering and blast wall construction were locat.;d at 460, 510, 600, 920 and 1,130 yards from ground zero. Mean blast pressures, in pounds/sq. inch, recorded inside the shelters are shown in the following table.

| Distance (yds.) | Presentation | | |
|---|---|---|---|
| | Front | Side | Rear |
| 460 | NR | NR | NR |
| 510 | 38 | 27 | 40 |
| 600 | 28 | 21 | 28 |
| 920 | 16 | 7 | 14 |
| 1130 | 8.5 | 4 | 5.5 |

Front presentation implies blast wall facing towards event.
Rear " " " " " away from event.
Side " " shelter side on to event.

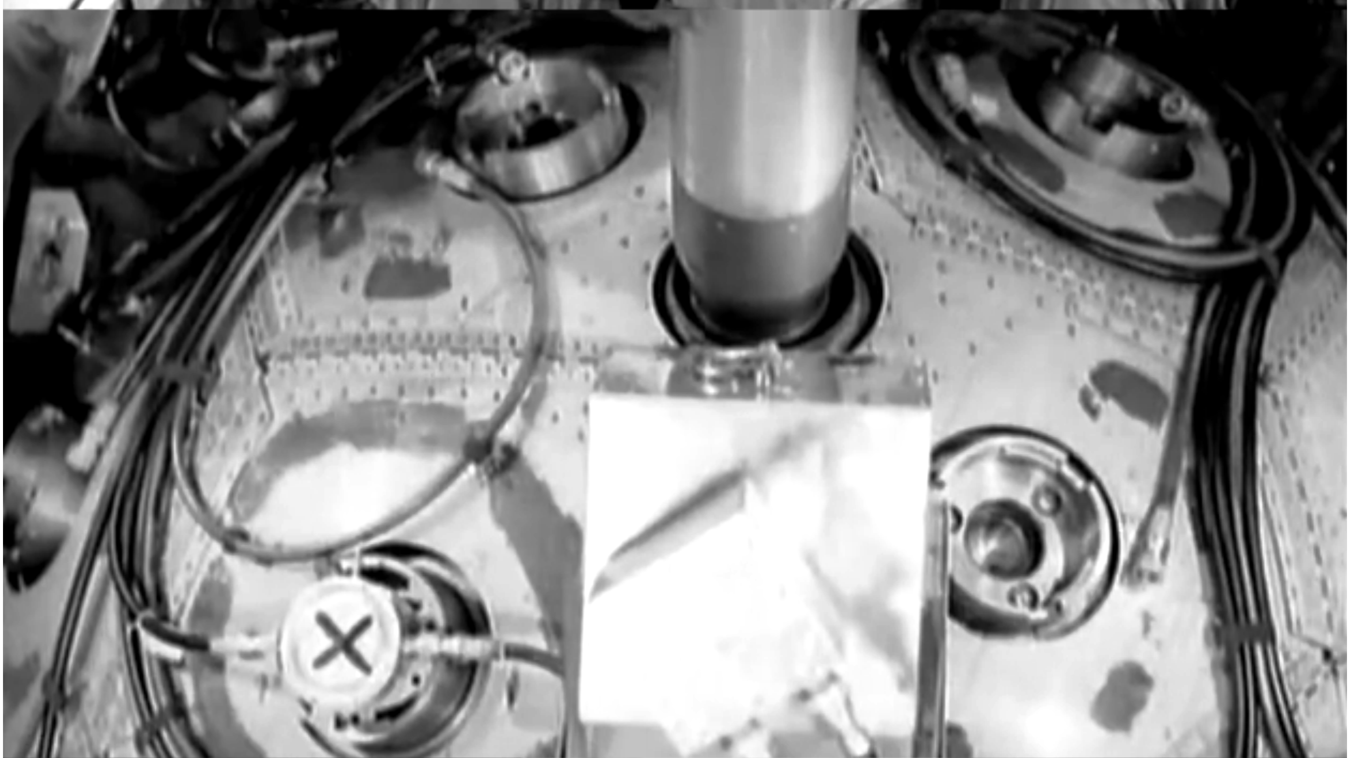
Shelters at 460, 510 and 600 yards suffered damage including demolition of blast walls, removal of sandbag covering and some displacement of the corrugated iron.

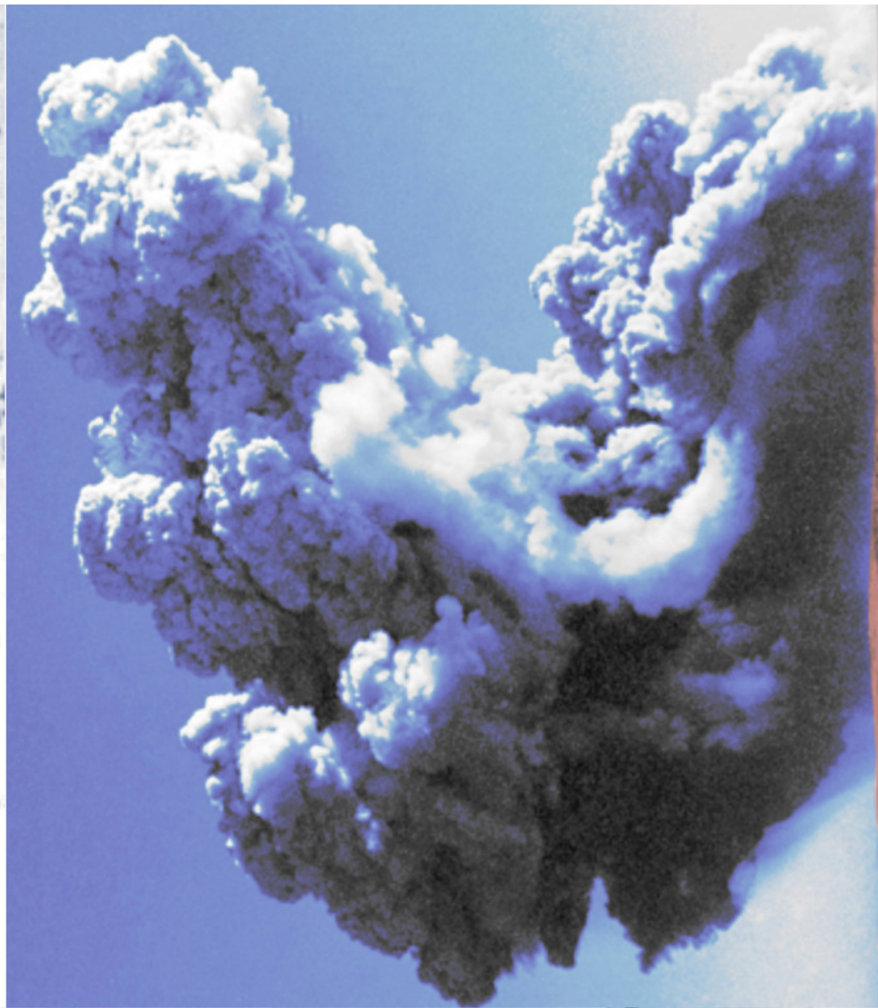
At 920 and 1,130 yards the shelters suffered relatively little damage.

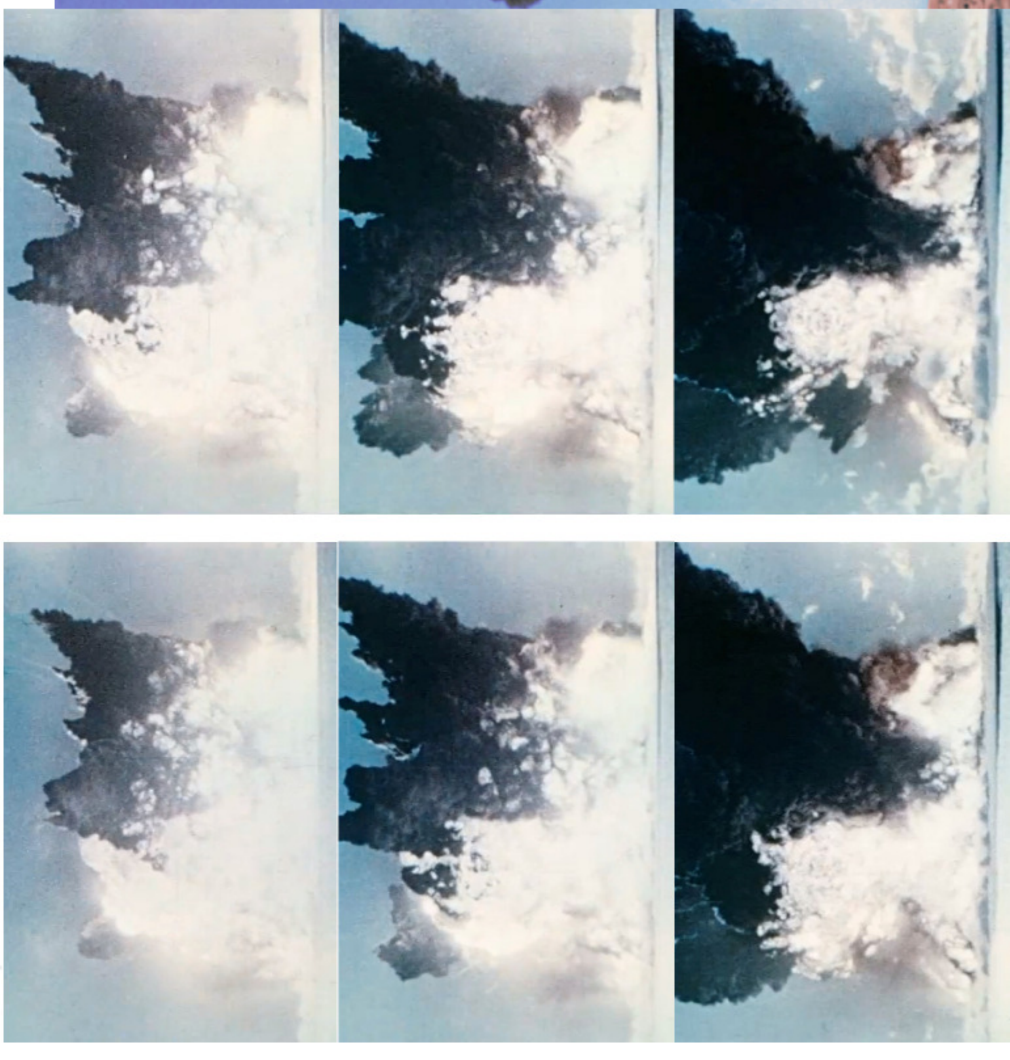
Civil defence authorities consider that there might have been some 50% survival from blast damage of personnel in shelters at 460 yards and some 90 per cent at 600 yards, fatal casualties being mainly due to secondary blast effects (e.g. debris) and not to direct effects on the person of the blast pressure itself. The front presentation appears the most hazardous, due to the collapse of the blast wall into the shelter. At such distances, however, the survival from the effects of gamma flash would have been virtually nil. (MORE EARTH COVER IS NEEDED FOR RADIATION.)

At 920 and 1,130 yards there would have been no casualties from blast, and incidentally, little risk from the effect of gamma flash.



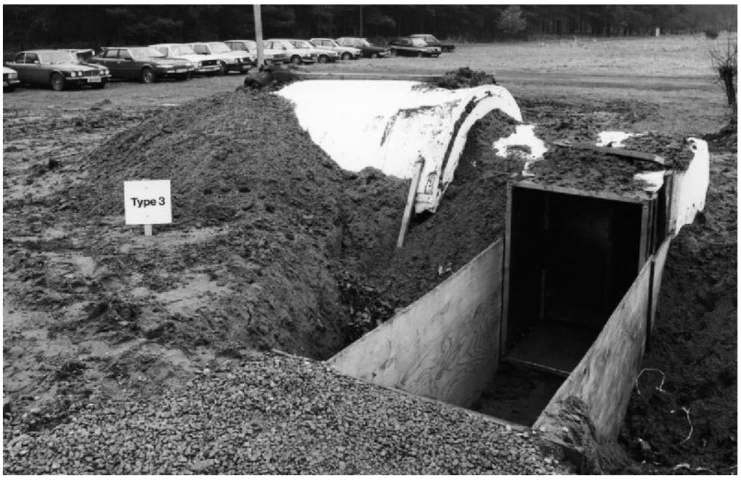






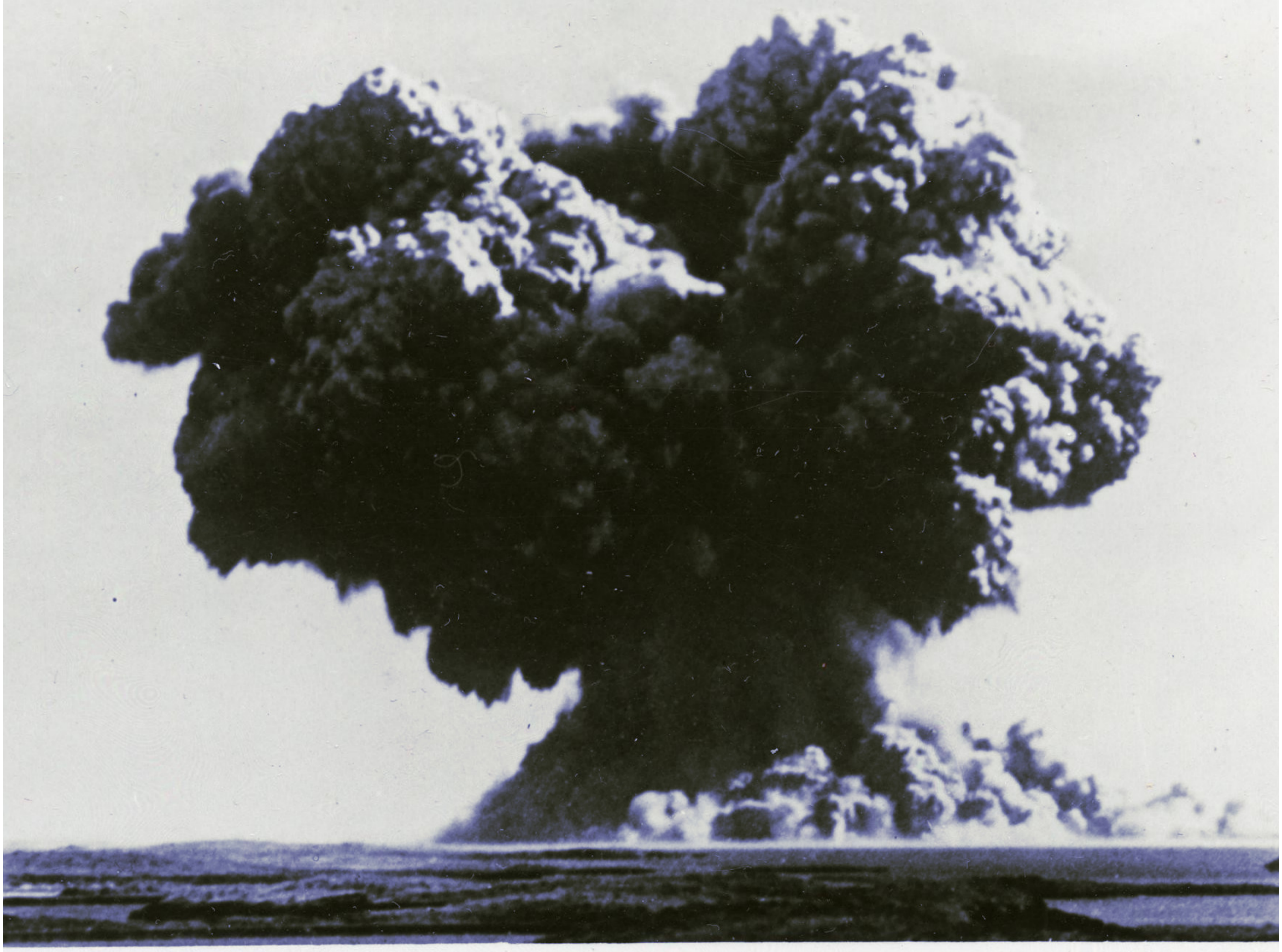
# Type 3 outdoor Anderson shelter

Anderson shelters exposed to Operation Hurricane nuclear test




Anderson shelter with earth cover (not sandbags) and radiation-shielded entrance at Home Defence College, Easingwold, York, 1980.

Earth covered shelter, Hiroshima (U.S. Strategic Bombing Survey)

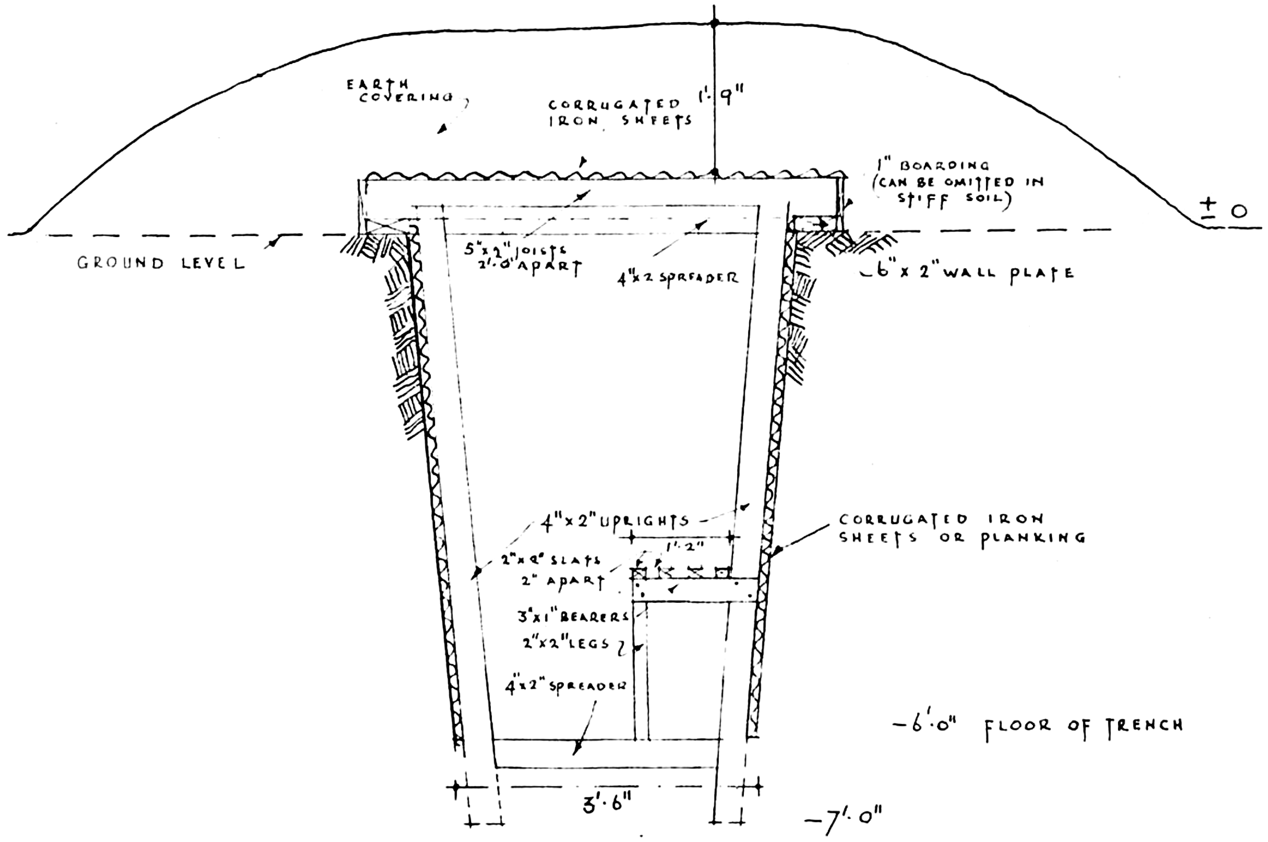


Real fallout decontamination: Oct 1952, ADM 280/966

**UK National Archives: HO 45 / 17589 / 3 Garden trench shelter 1938-9**

# GARDEN TRENCH SHELTER

## HOME OFFICE A.R.P. DEPARTMENT




**National Archives: HO45 / 17590 Nissen corrugated steel shelter 1938**

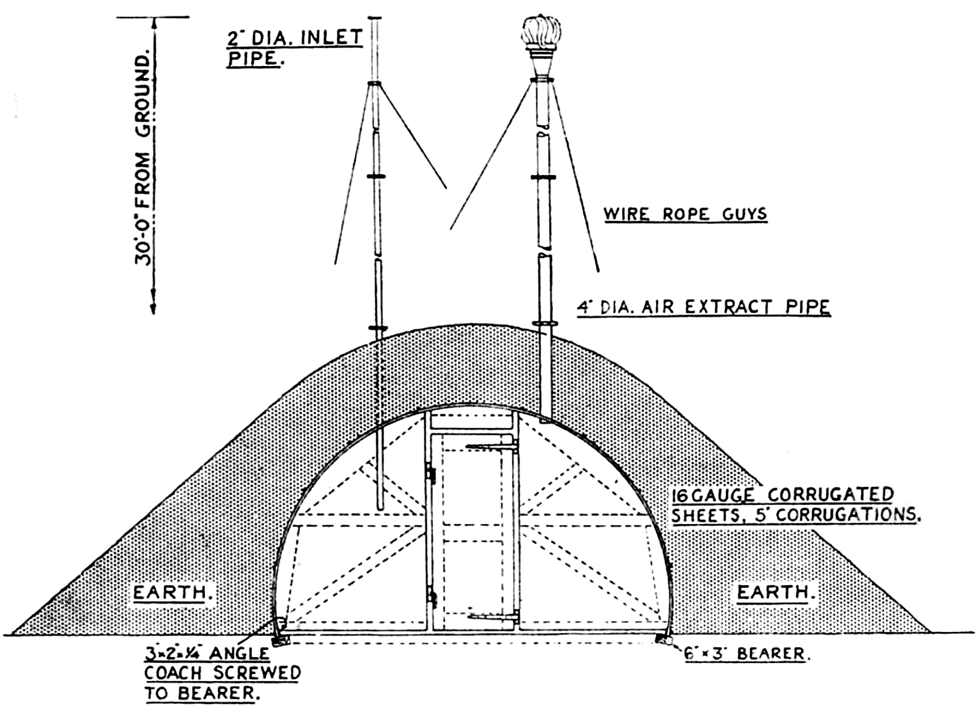
# THE NISSEN AIR RAID SHELTER

## CAPACITY· 50 PERSONS.

INCHES 12 0 5 10 15 20 25

SCALE OF FEET.

PATENT APPLIED FOR IN CONNECTION WITH VENTILATING PIPES.



UK NATIONAL ARCHIVES: ES 5/2

ANDERSON SHELTER TESTS AGAINST 25 KT NUCLEAR NEAR SURFACE BURST (2.7 METRES DEPTH IN SHIP)

AWRE-T1/54, 27 Aug. 1954

# SECRET—GUARD

## ATOMIC WEAPONS RESEARCH ESTABLISHMENT
(formerly of Ministry of Supply)

## SCIENTIFIC DATA OBTAINED AT OPERATION HURRICANE
(Monte Bello Islands, Australia—October, 1952)

### 12.1. *Blast Damage to Anderson Shelters*

At 1,380 feet, Fig. 12.1, parts of the main structure of the shelters facing towards and sideways to the explosion were blown in but the main structure of the one facing away from the explosion was intact, and would have given full protection. At 1,530 feet, Fig. 12.2, the front sheets of the shelter facing the explosion were blown into the shelter but otherwise the main structures were more or less undamaged, as were those at 1,800 feet, Fig. 12.3.

Operation Hurricane nuclear test Anderson shelters used sandbags which gave no "earth arching" protection, unlike packed soil cover used over London Anderson shelters, 1940:

## 13. The Penetration of the Gamma Flash

### 13.1. *Experiments on the Protection from the Gamma Flash afforded by Slit Trenches*

13.1.1. The experiments described in this section show that slit trenches provide a considerable measure of protection from the gamma flash. From the point of view of Service and Civil Defence authorities this is one of the most important results of the trial.

13.1.2. Rectangular slit trenches 6 ft. by 2 ft. in plan and 6 ft. deep were placed at 733, 943 and 1,300 yards from the bomb and circular fox holes 2 ft. in radius and 6 ft. deep were placed at 943 and 1,300 yards.

The doses received from the flash were measured with film badges and quartz-fibre dosimeters in order to determine the variation of protection with distance, with depth and with orientation of the trench and the relative protection afforded by open and covered trenches.

In general, the slit trenches were placed broadside-on to the target vessel but at 1,300 yards one trench was placed end-on. Two trenches, one at 733 and one at 943 yards were covered with the equivalent of 11 inches of sand.

Table 13.1

*Variation of Gamma Flash Dose on Vertical Axis of Trench*

| Type of trench | Rectangular broadside-on open | | | Rectangular end-on open | Circular open | | Rectangular broadside-on covered | |
|---|---|---|---|---|---|---|---|---|
| Distance (yards) ... | 1,300 | 943 | 733 | 1,300 | 1,300 | 943 | 943 | 733 |
| Surface dose (Roentgens) | 300 | 3,000 | 14,000 | 300 | 300 | 3,000 | 3,000 | 14,000 |
| Depth below ground level (inches) | | | | | | | | |
| 6 ... | 150 | 1,000 | — | 230 | 214 | 1,200 | (75) | — |
| 12 ... | 75 | 430 | — | 150 | 120 | 545 | 47·6 | — |
| 24 ... | 33·3 | 150 | 584 | 60 | 54·5 | 188 | 25 | (140) |
| 36 ... | 23 | 70 | 216 | 31·6 | 30 | 86 | 13 | (56) |
| 48 ... | (20) | 43 | 100 | 20 | 17·7 | 48·5 | 7·7 | (31) |
| 60 ... | — | (37·5) | 61 | 13·6 | 10·7 | (33·3) | 5 | (23) |
| 72 ... | — | — | (46·7) | (8·6) | 7 | — | (3·5) | — |

Entries in brackets are extrapolations or estimates.

Trench air raid shelter in Kent hop field 15 Aug 1940

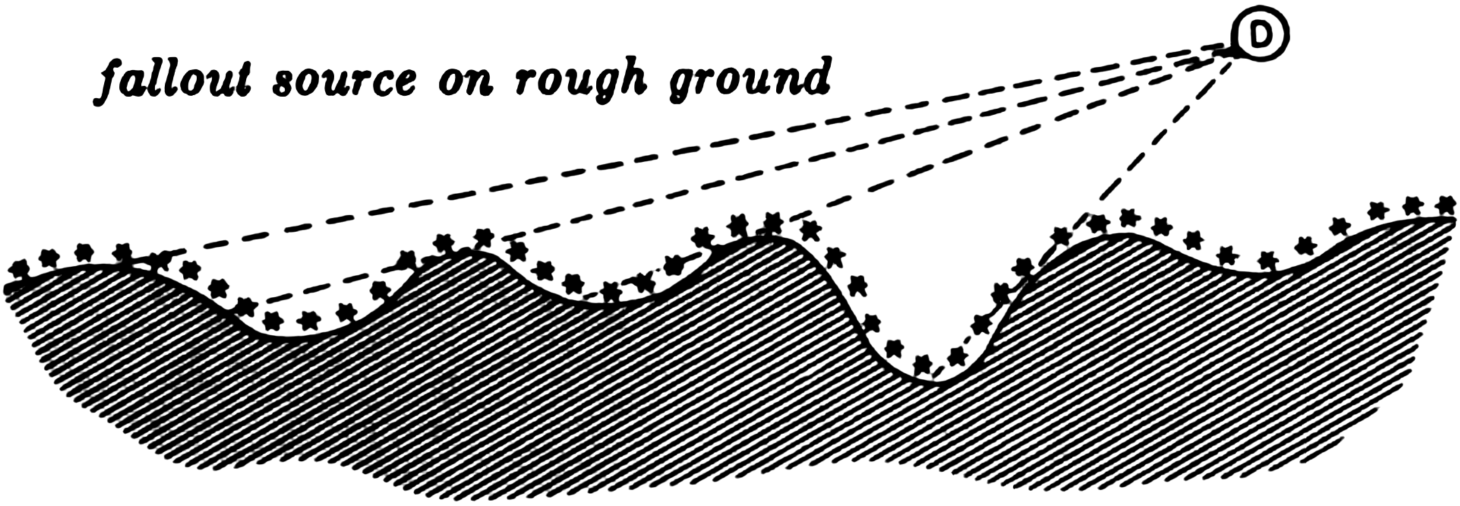
Exercise Desert Rock VI (Nevada, 1955), 6 ft trench at 4,000 yds from GZ

MET shot (1955): road graders survive 30 psi peak overpressure in open trench

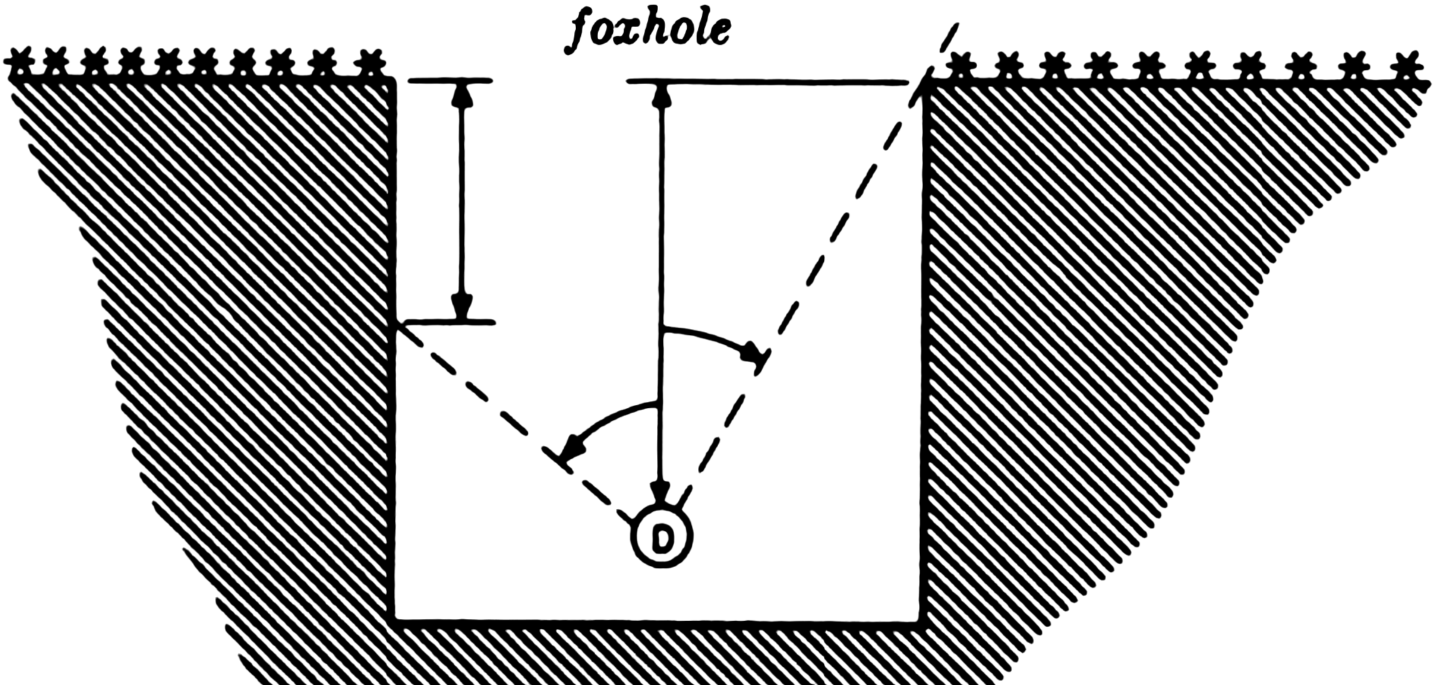
Source: Glasstone, Effects of Nuclear Weapons, 1957

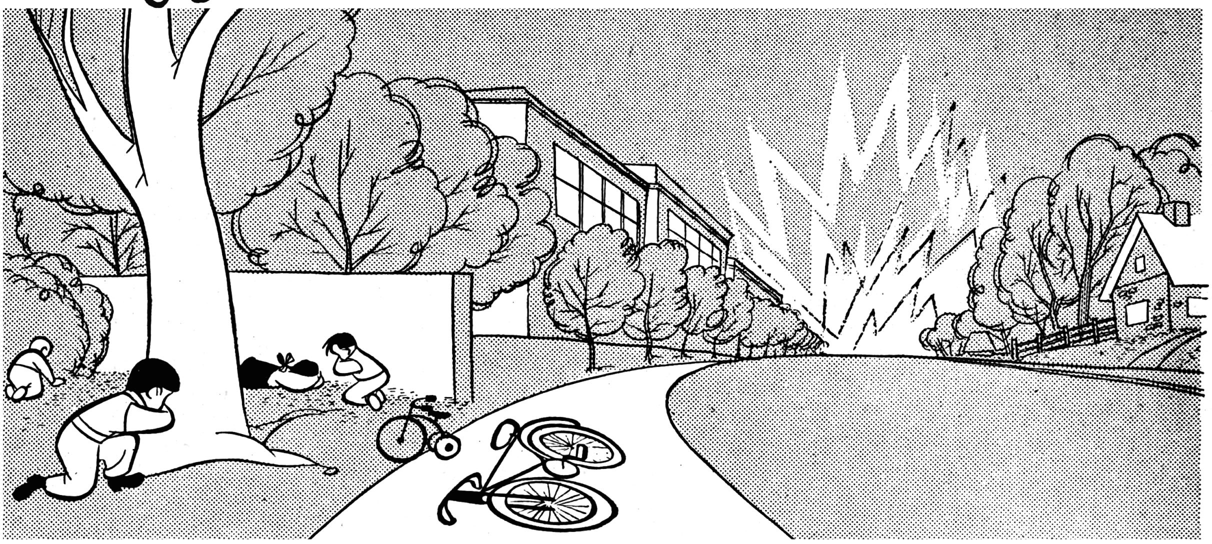
Nevada test site, 8 May 1953: 27 kiloton ENCORE nuclear weapon test

**Because 90% of the gamma dose from deposited fallout comes from long-ranged direct gamma rays (not air scatter), those rays are mostly coming nearly horizontally (50% of the gamma dose comes from beyond a 15 metre radius on smooth terrain). Hence, small surface irregularities form hills and valleys, shielding (to some extent) about 50% of the direct gamma rays from the observer at 1 metre height:**




**Open foxholes give excellent protection if fallout is simply scraped out:**



SO, LIKE BERT, YOU **DUCK** TO AVOID THE THINGS FLYING THROUGH THE AIR...

...AND **COVER** TO KEEP FROM GETTING CUT OR EVEN BADLY BURNED.

# AIR WAR AND EMOTIONAL STRESS

## Psychological Studies of Bombing and Civilian Defense

Irving L. Janis

The RAND Corporation

1951



Time from flash to blast = 4 sec at 1 mile:

A substantial proportion of the respondents in Hiroshima and Nagasaki reported having reacted immediately to the intense flash alone, as though it were a well-known danger signal, despite the fact that they were unaware of its significance at the time. A number of them said that they voluntarily ducked down or "hit the ground" as soon as the flash occurred and had already reached the prone position before the blast swept over them.



From the above discussion, it is apparent that some of the survivors immediately perceived the flash as a danger signal. It also appears that for those who were not located near the center there was an opportunity to take protective action that could reduce injuries from the secondary heat wave and from flying glass, falling debris, and other blast effects. It is noteworthy that some survivors evidently failed to make use of this opportunity, as is to be expected when there has been no prior preparation for it.

In a later chapter on the problems of civil defense, we shall have occasion to take account of these findings, since they suggest that casualties in an A-bomb attack might be reduced if the population has been well prepared in advance to react appropriately to the flash of the explosion.

# HIROSHIMA

*John Hersey*

NEW YORKER *of* 31 *August*, 1946

## I

## A NOISELESS FLASH

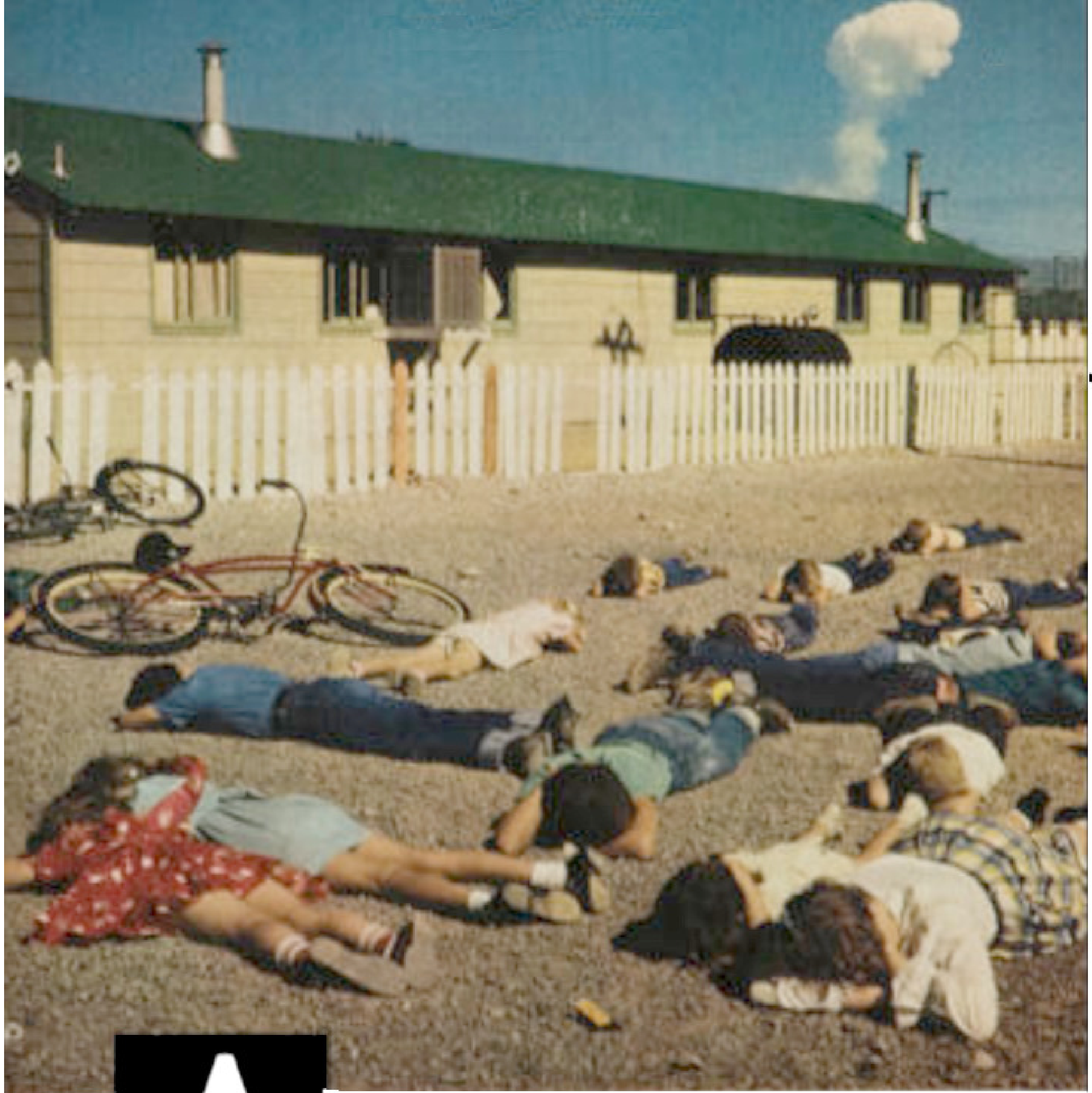
AT exactly fifteen minutes past eight in the morning, on August 6th, 1945, Japanese time, at the moment when the atomic bomb flashed above Hiroshima,

Dr. Terufumi Sasaki, a young member of the surgical staff of the city's large, modern Red Cross Hospital, walked along one of the hospital corridors

He was one step beyond an open window when the light of the bomb was reflected, like a gigantic photographic flash, in the corridor. He ducked down on one knee and said to himself, as only a Japanese would, "Sasaki, *gambare!* Be brave!" Just then (the building was 1,650 yards from the centre), the blast ripped through the hospital. The glasses he was wearing flew off his face; the bottle of blood crashed against one wall; his Japanese slippers zipped out from under his feet—but otherwise, thanks to where he stood, he was untouched.

Dr. Sasaki shouted the name of the chief surgeon and rushed around to the man's office and found him terribly cut by glass.

Starting east and west from the actual centre, the scientists, in early September, made new measurements, and the highest radiation they found this time was 3.9 times the natural "leak."



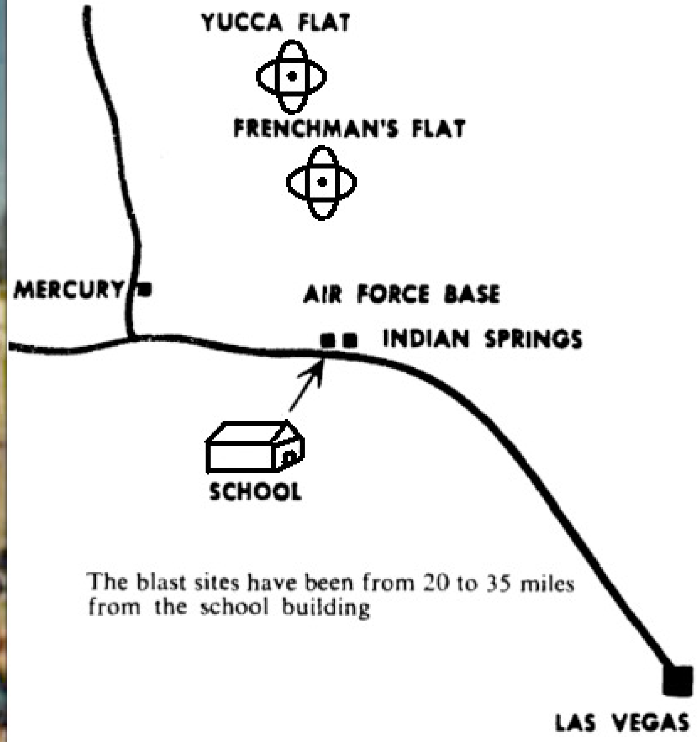
# A IS FOR ATOM

By ROBERT CAHN

*A dozen times, the awesome mushroom has risen in view of these youngsters, 25 miles from the Nevada test sites. Here's the story of our most atom-wise kids*

Collier's Weekly, June 21, 1952, pp. 15-17

Indian Springs (whose permanent population is 17) and adjacent air base are 42 miles from Las Vegas




The blast sites have been from 20 to 35 miles from the school building

SEVERAL months ago, the people of the nation learned with some interest that for the first time combat troops were to witness an atomic bomb test from close up. But to the youngsters at Indian Springs Public School, near Las Vegas, Nevada, such an experiment was old-hat. They already had seen, from less than 25 miles away, more atomic bomb blasts than anyone in the world except for the handful of nuclear scientists and technicians who set them off.

Starting last October, when the influx of atomic, military and construction personnel brought more than 200 families into the area, the Indian Springs school had become an unplanned experiment in the indoctrination of young children to atomic bombs.

"The children at this school, by their sheer proximity to the tests, are getting the same type of psychological indoctrination we are giving some of our combat troops," an Atomic Energy Commission spokesman commented recently. "If all the school children in the nation could witness an A-bomb blast, it would do much to destroy the fear and uncertainty which now exist."

Eighth-grader Dick Bower, thirteen, says he was once told at an atomic bomb drill in a southern California school that there was a possibility the whole earth could be blown up if enough such bombs were exploded. "I was really scared when we moved up here," Dick says, "but I have seen a couple of bombs go off now and it's just ordinary."

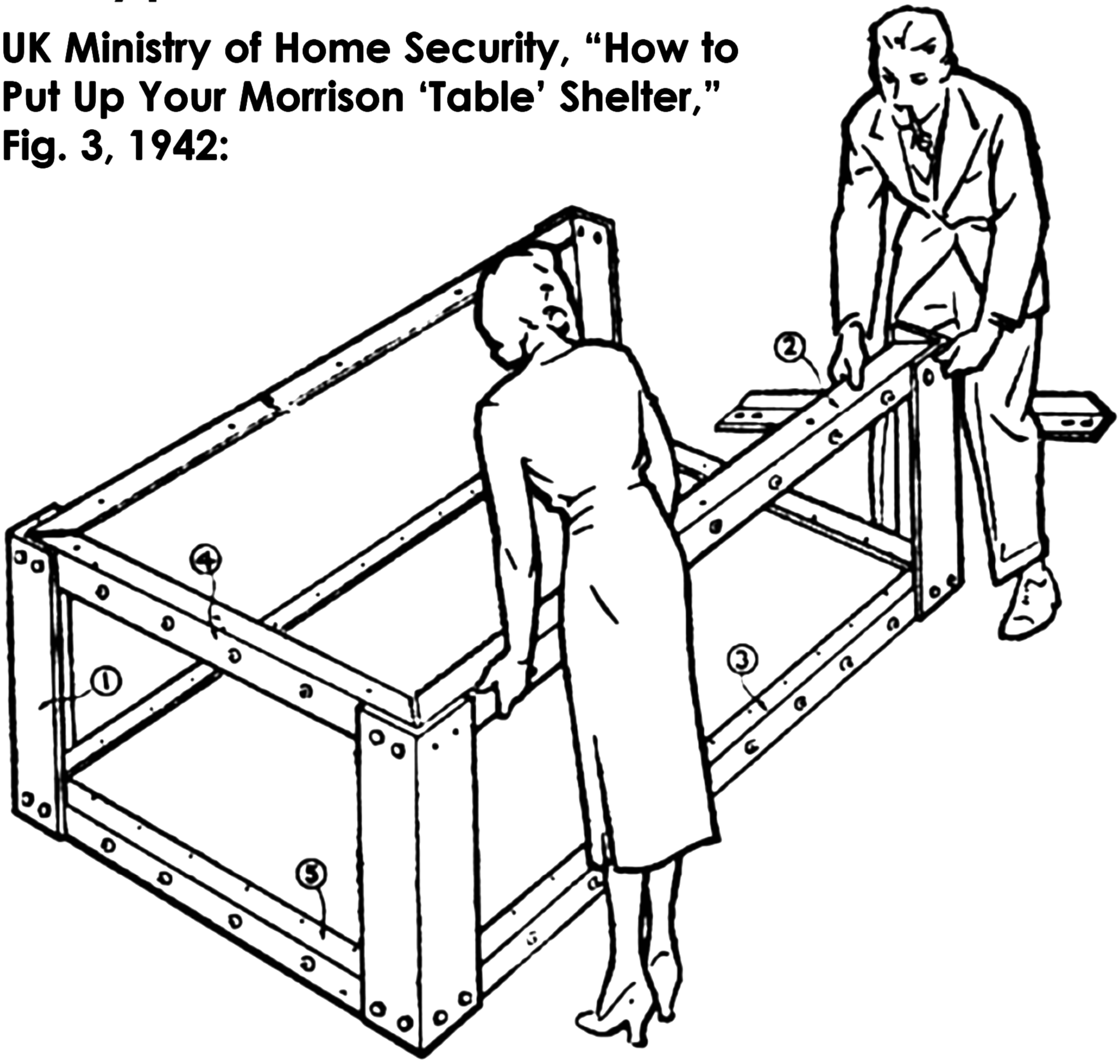
# DOMESTIC NUCLEAR SHELTERS

Advice on
domestic shelters
providing protection
against
nuclear explosions

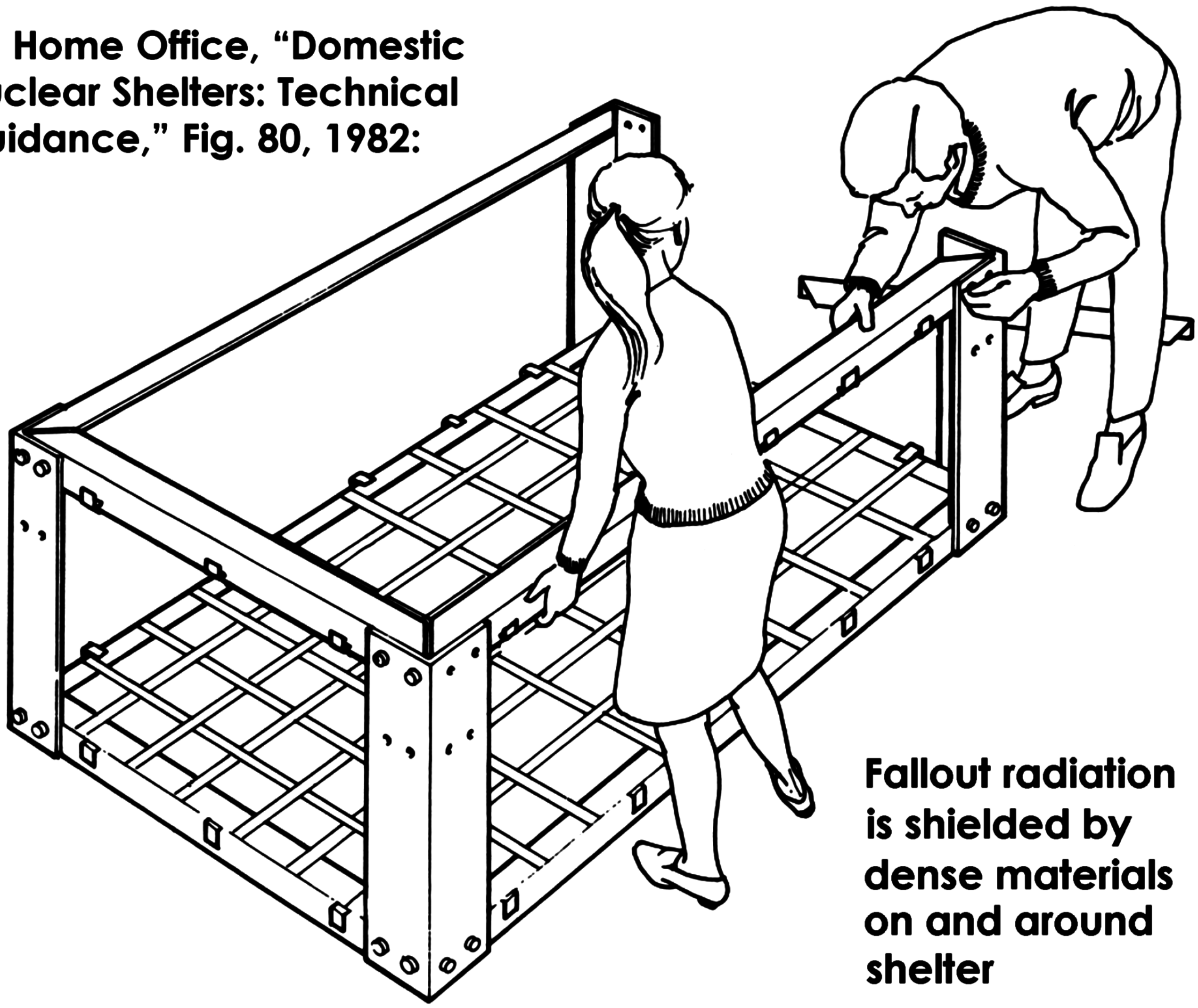
A Home Office guide

# Type 2 indoor Morrison shelter

**UK Ministry of Home Security, “How to Put Up Your Morrison ‘Table’ Shelter,” Fig. 3, 1942:**

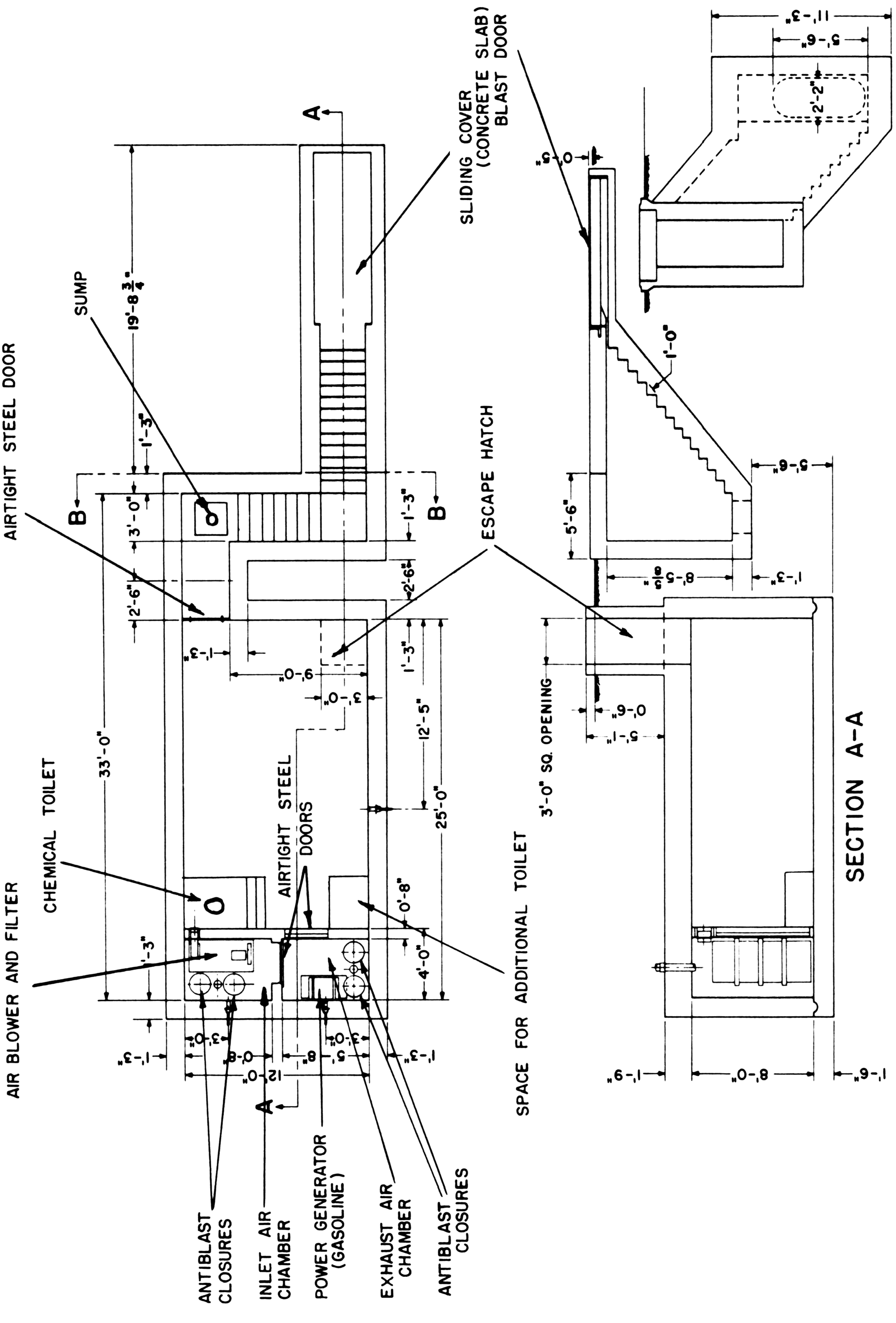



**UK Home Office, “Domestic Nuclear Shelters: Technical Guidance,” Fig. 80, 1982:**



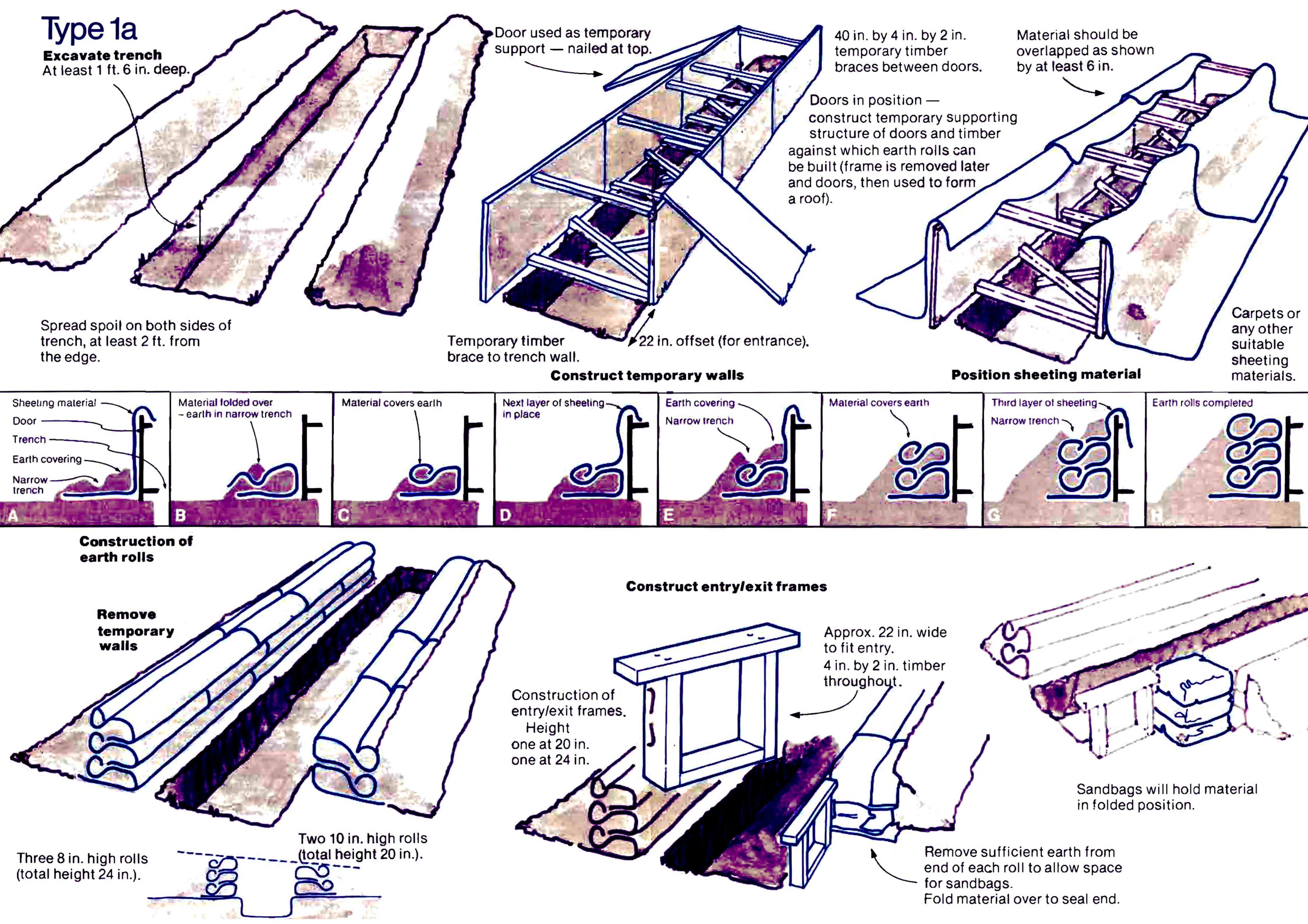
**Fallout radiation is shielded by dense materials on and around shelter**

# Type 4 reinforced concrete shelter (Nevada bomb test)
# Fig. 12.54 in Glasstone Effects of Nuclear Weapons, 1957




Sectional plan and section of underground personnel shelter

# Type 1a



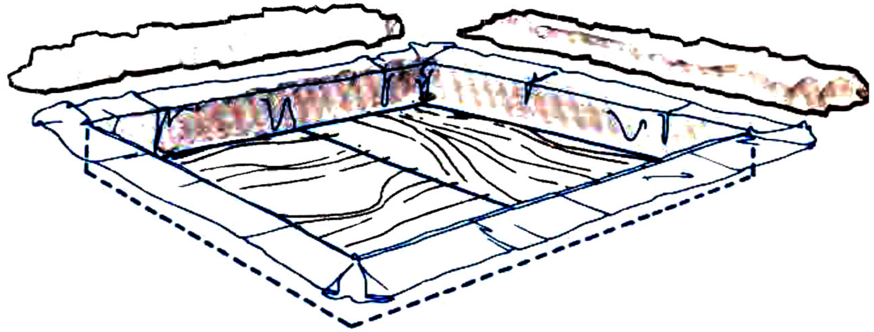
Excavate trench
At least 1 ft. 6 in. deep.
Spread spoil on both sides of trench, at least 2 ft. from the edge.
Door used as temporary support — nailed at top.
40 in. by 4 in. by 2 in. temporary timber braces between doors.
Doors in position — construct temporary supporting structure of doors and timber against which earth rolls can be built (frame is removed later and doors, then used to form a roof).
Temporary timber brace to trench wall.
22 in. offset (for entrance).
Construct temporary walls
Material should be overlapped as shown by at least 6 in.
Carpets or any other suitable sheeting materials.
Position sheeting material
Sheeting material
Door
Trench
Earth covering
Narrow trench
A
Material folded over – earth in narrow trench
B
Material covers earth
C
Next layer of sheeting in place
D
Earth covering
Narrow trench
E
Material covers earth
F
Third layer of sheeting
Narrow trench
G
Earth rolls completed
H
Construction of earth rolls
Remove temporary walls
Three 8 in. high rolls (total height 24 in.).
Two 10 in. high rolls (total height 20 in.).
Construct entry/exit frames
Construction of entry/exit frames.
Height
one at 20 in.
one at 24 in.
Approx. 22 in. wide to fit entry.
4 in. by 2 in. timber throughout.
Remove sufficient earth from end of each roll to allow space for sandbags.
Fold material over to seal end.
Sandbags will hold material in folded position.


Type 1a earth-covered doors-over trench shelter
Home Office Scientific Advisory Branch (Home Defence College, Easingwold, York, 1980)

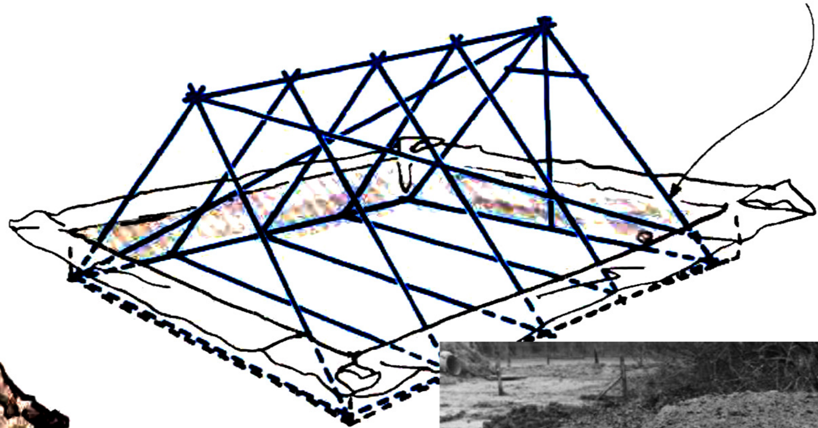
# Type 1b

Improvised outdoor shelter

Prepare a trench 8 ft. x 8 ft. and at least 1 ft. 6 in. deep. Line it with heavy duty polythene sheeting. Lay a floor of two sheets of plywood, ¾ in. thick and 4 ft. x 8 ft.

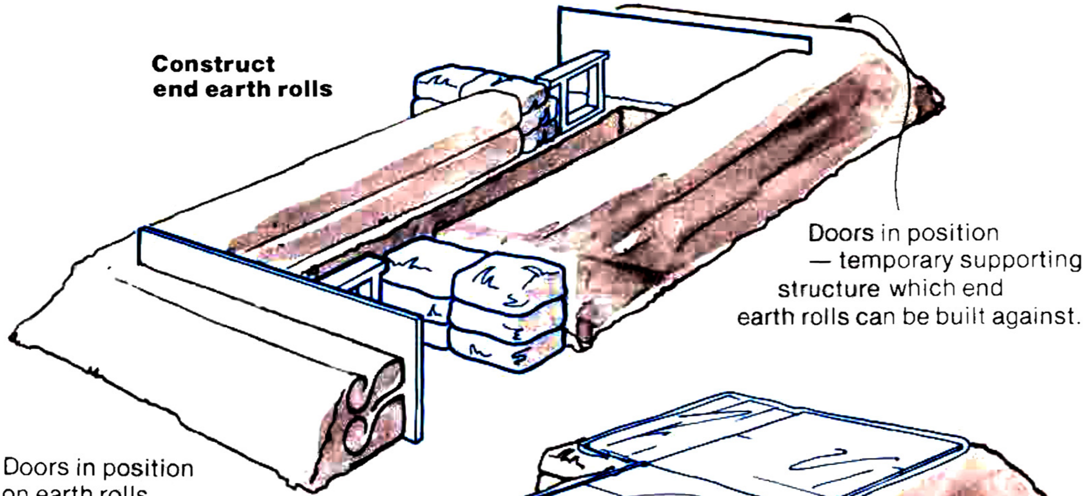


Construct the frame of scaffold poles (or you could use wood). This should be as strong as you can make it. You can increase the strength with vertical and diagonal bracing, or crossbars.



**Construct end earth rolls**

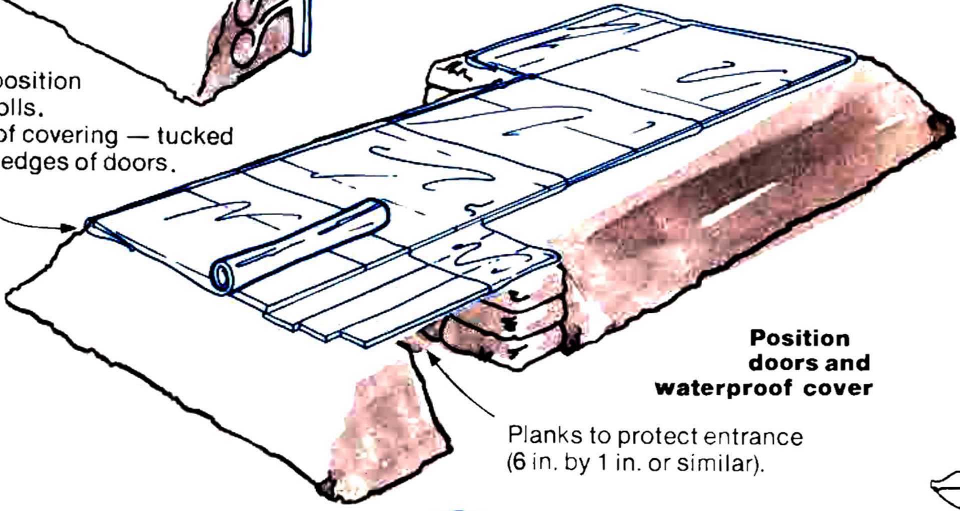
Doors in position — temporary supporting structure which end earth rolls can be built against.



Doors in position on earth rolls. Waterproof covering — tucked under the edges of doors.

Planks to protect entrance (6 in. by 1 in. or similar).

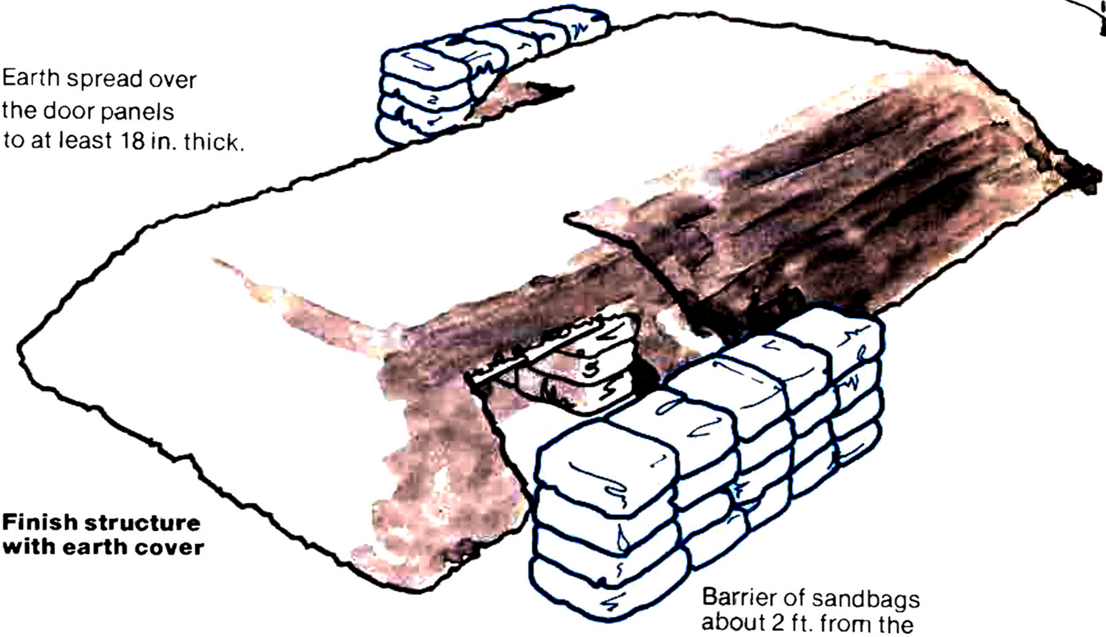
**Position doors and waterproof cover**



Earth spread over the door panels to at least 18 in. thick.

Barrier of sandbags about 2 ft. from the entrance

**Finish structure with earth cover**

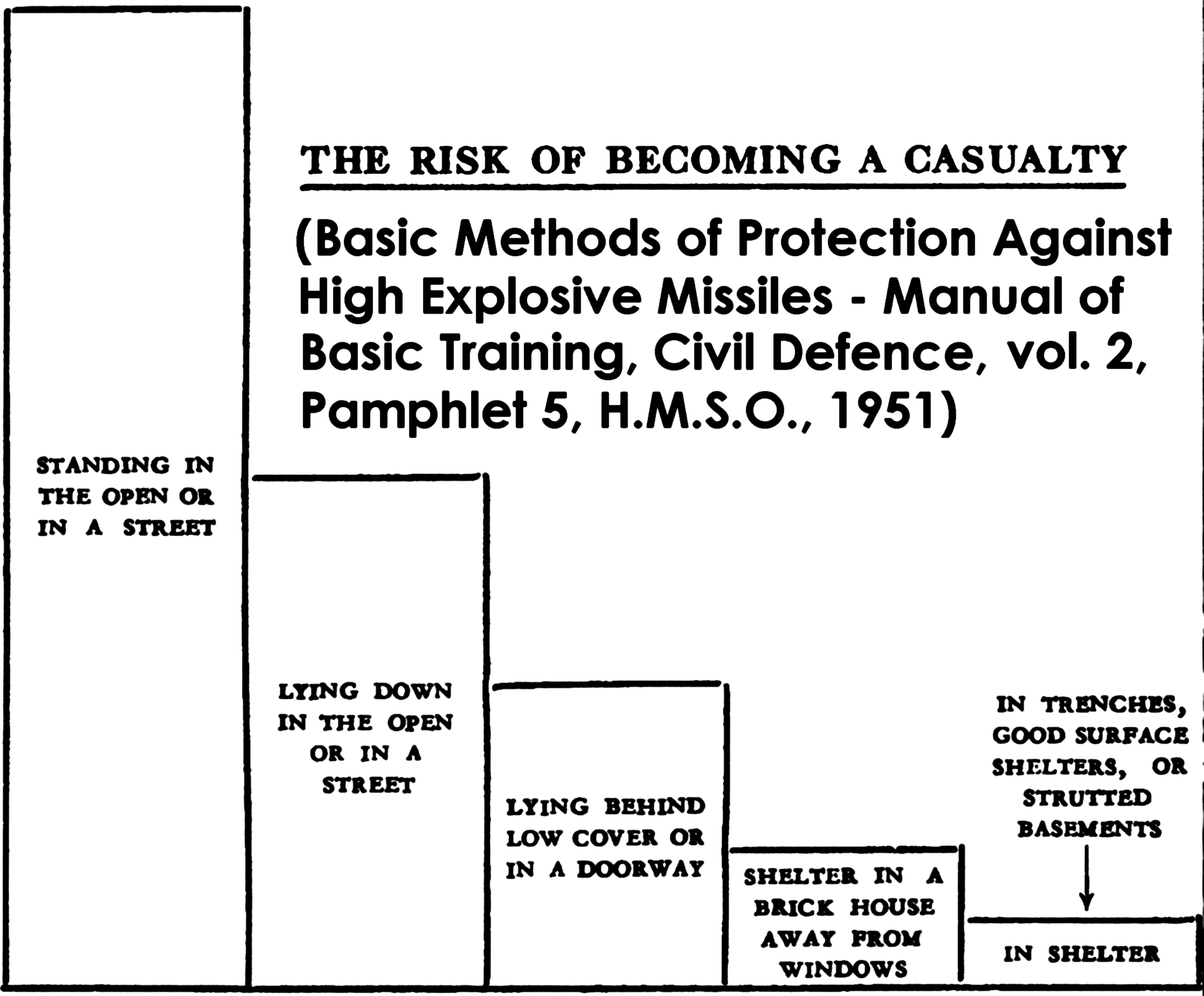



**Type 1b earth-covered scaffold/wood pole A-frame shelter, in 1980 at Home Defence College, Easingwold, York**

It cannot be too strongly emphasised that it is most important, from the point of view of reducing casualties as a whole, for everyone in an area under attack to make use of any shelter that is available. Recent research has shown that there would be less fatal casualties if everyone were in relatively poor shelter than if half the population were in shelter twice as good and the other half remained in the open.

## THE RISK OF BECOMING A CASUALTY

**(Basic Methods of Protection Against High Explosive Missiles - Manual of Basic Training, Civil Defence, vol. 2, Pamphlet 5, H.M.S.O., 1951)**

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# HOME OFFICE

## OFFICE OF THE CHIEF SCIENTIFIC ADVISER

### A COMPARISON BETWEEN THE NUMBER OF PEOPLE KILLED PER TONNE OF BOMBS DURING WORLD WAR I AND WORLD WAR II

---

**BOMB SIZES**

=> ≈ 175 kg

For World War II the average bomb weight was between 150 - 200 kg. (R.C. 268, Table 6), whereas for World War I the majority of bombs were 12 or 50 kg.

---

**TABLE 5**

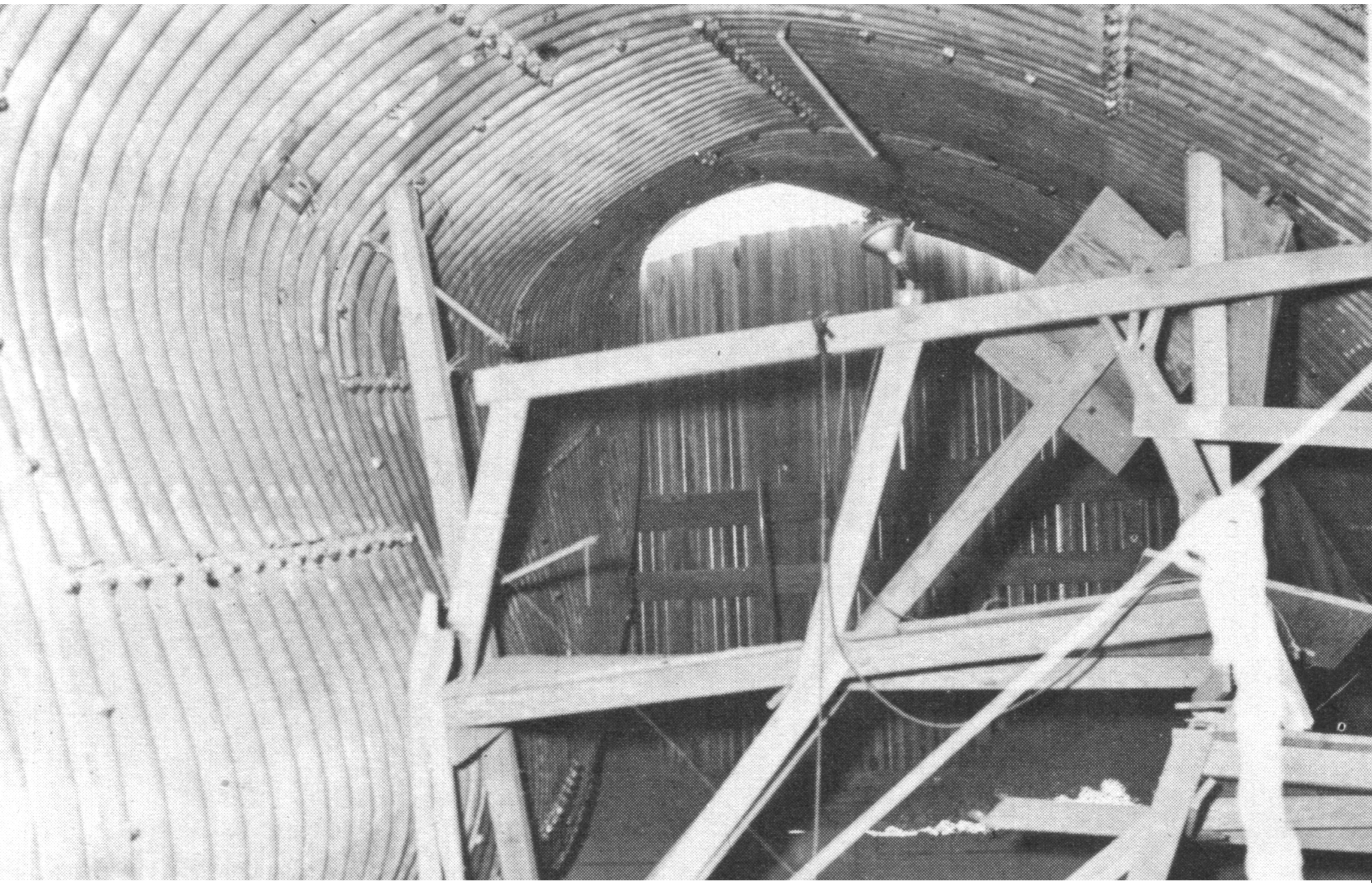
**Relative safeties in World War II deduced from population and casualty distribution**

| | In the open | Under cover | In shelter |
|---|---|---|---|
| Population exposure | 5% | 60% | 35% |
| Location people killed | 19% | 62% | 19% |
| Relative safety<br>RELATIVE DANGER! | 72% | 20% | 10% |

(1) A house about 3½ times as safe as in the open.
(2) A shelter about twice as safe as a house.

---

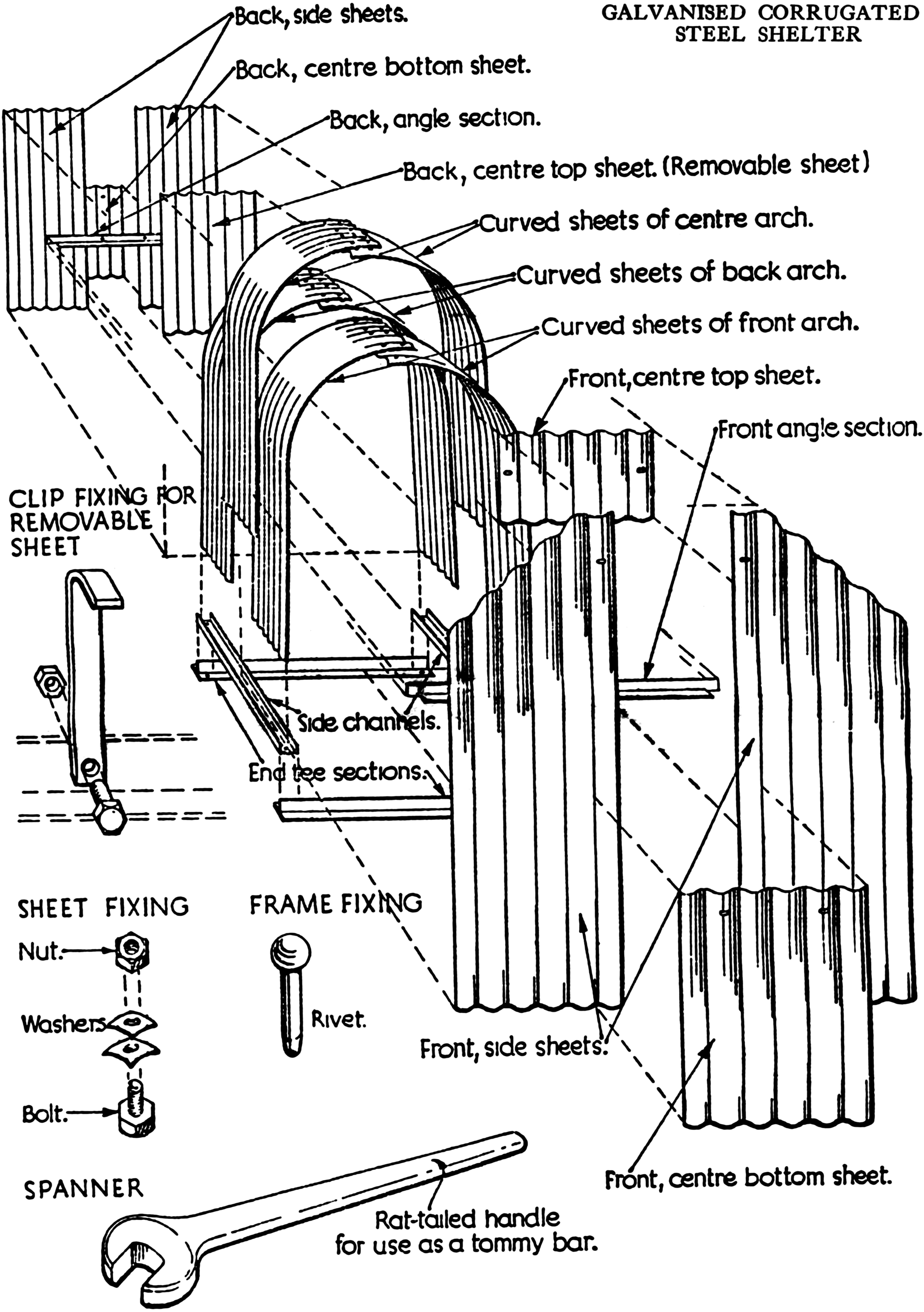
Table 6 also shows the location of killed which is implied by each of the possible population exposures. The only evidence available on this point is that, for the day raid on June 13th, 1916, in which the total number killed was 59, 69.5% of the people killed in the City were in the open.



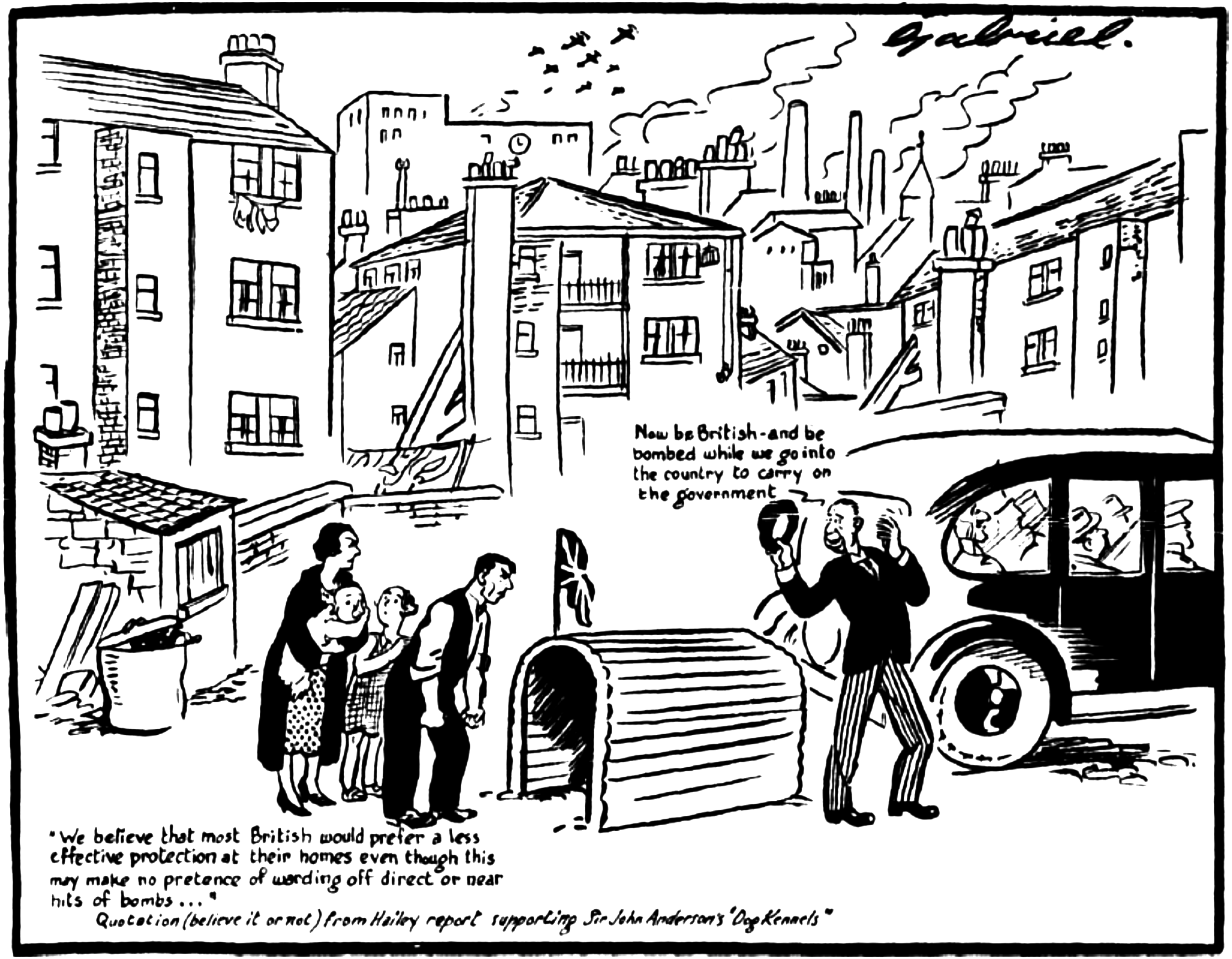
## DAMAGE CRITERIA FOR SHALLOW BURIED OR EARTH COVERED SURFACE STRUCTURES

| Type of structure | Damage class | Peak over-pressure (psi) | Nature of damage |
|---|---|---|---|
| Light, corrugated steel arch, surface structure (10-gage corrugated steel with a span of 20 to 25 feet) with 3 feet of earth cover over the crown. | A | 35–40 | Complete collapse. |
| | B | 30–35 | Collapse of portion of arch facing blast. |
| | C | 20–25 | Deformation of end walls and arch, possible entrance door damage. |
| | D | 10–15 | Possible damage to ventilation system and entrance door. |

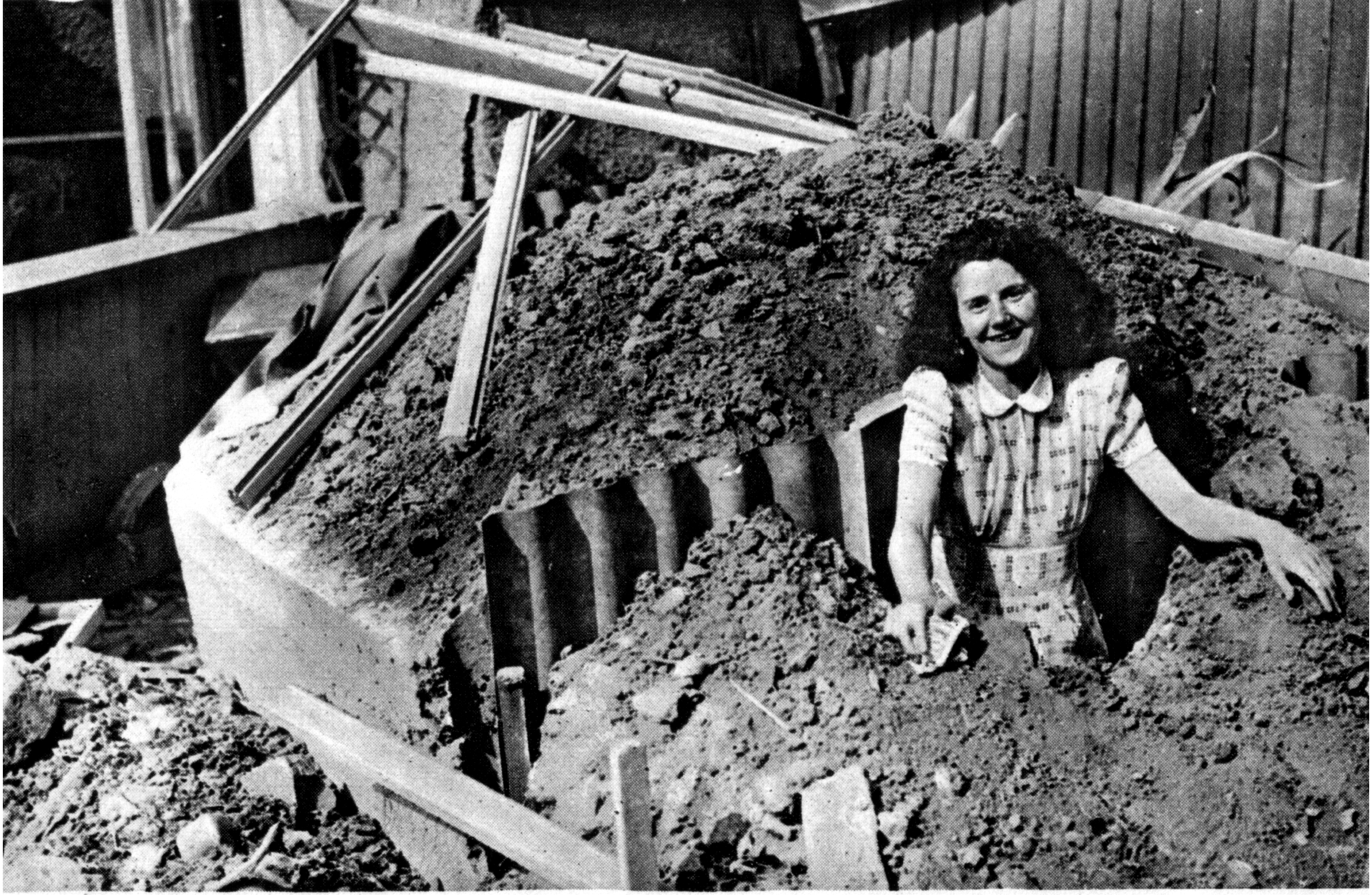
SOURCE: DR SAMUEL GLASSTONE,
THE EFFECTS OF NUCLEAR WEAPONS,
U.S. DEPARTMENT OF DEFENSE, 1957




ANDERSON SHELTER




IF WAR SHOULD COME!



ILLUSTRATED LONDON NEWS—Aug. 24, 1940

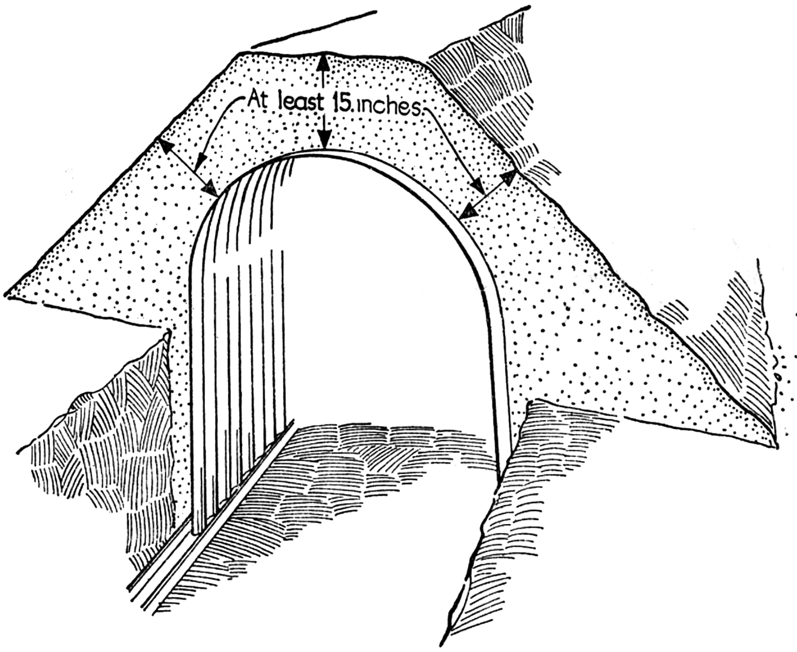
**GIVING THE LIE TO GOEBBELS: MRS. E. CULLEN SMILINGLY LEAVING THE EMERGENCY EXIT—A BOMB HAVING BLOCKED THE SHELTER ENTRANCE.** (*Planet.*)

ILLUSTRATED LONDON NEWS—AUG. 24, 1940

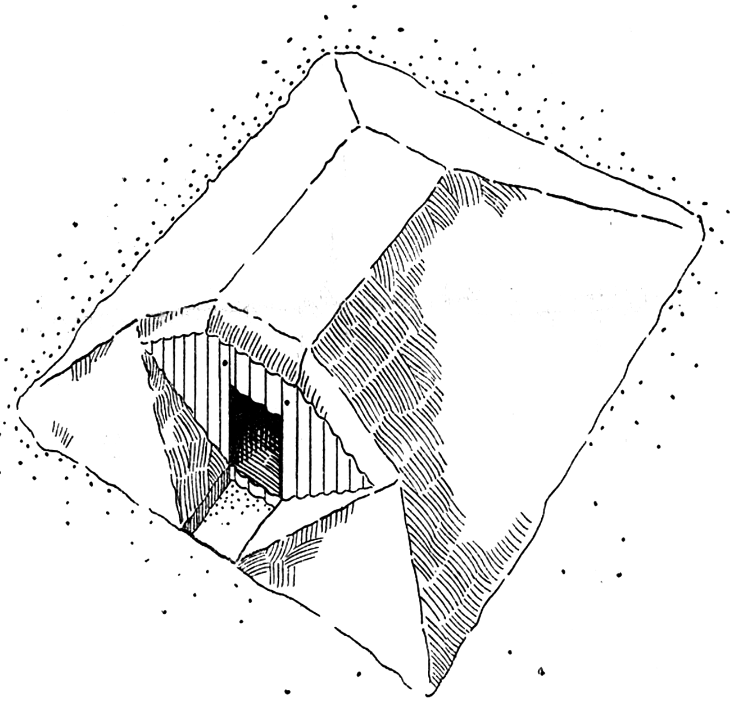
**MR. AND MRS. SHERMAN, OF CROYDON, WITH THEIR BABY, BY THEIR SHELTER, ON EACH SIDE OF WHICH BOMBS BURST.** (*G.P.U.*)

# Anderson shelter survives, Croydon, October 1940

29 July 1944: St Johns Rd, London, Mr and Mrs Dermott and Sgt Harrington




COVERING THE SHELTER WITH EARTH.



THE SHELTER COMPLETE WITH EARTH COVER.

# Anderson shelter survives hit: Norwich 27 April 1942

# AFFORDING STRIKING PROOF OF THE EFFICACY OF ANDERSON SHELTERS:
## ALMOST MIRACULOUS ESCAPES IN MIDLAND AND SOUTH OF ENGLAND HOMES.

AN ANDERSON SHELTER, CORRECTLY COVERED WITH EARTH (FROM WHICH CABBAGES SPROUT), UNHARMED DESPITE SURROUNDING BOMB DAMAGE. *Wide World.*

DAMAGED HOUSES, WITH AN UNTOUCHED ANDERSON SHELTER IN THE FOREGROUND, WHOSE OCCUPANTS FOUND COMPLETE SAFETY. *(Planet.)*

INTACT AMONG THE DÉBRIS CAUSED BY GERMAN BOMBS: AN ANDERSON SHELTER IN A S.-W. LONDON SUBURB. *(Planet.)*

TWO ANDERSON SHELTERS IN THE SAME DISTRICT AS THAT SHOWN IN THE PHOTOGRAPH ON THE LEFT, ALSO INTACT. *(Planet.)*

A LARGE BOMB-CRATER BEHIND A ROW OF DAMAGED HOUSES AFTER THE CROYDON RAID: THE SHELTERS WERE UNAFFECTED. *(Keystone.)*

The violent and very expensive raids by the *Luftwaffe* in the week ending August 17 provided a most reassuring demonstration of the efficacy of the Anderson shelter, when it has been properly covered with earth and the entrance adequately screened. Both at Croydon and in the Midlands its value was proved. When a bomb dropped in the middle of a triangle formed of three Anderson shelters in a Midlands town the occupants of all escaped unhurt. Seven people taking cover in a home-made shelter, however, were killed. Seven persons sheltering in an Anderson shelter in another Midlands area were unharmed by a bomb which exploded immediately outside it. When sixteen Nazi bombers were caught at Tilbury (Essex) between the A.-A. barrage and "Spitfires," they scattered and fled to sea with a vicious pursuit encouraging them. Six of their bombs fell on a housing estate. Four exploded harmlessly on grass verges, and two blew out the sides of a council house, but the occupants were in their Anderson shelter, less than ten yards away, and were unhurt. One man in South London, with his wife and two children, who had been evacuated from Folkestone, said that they were in an Anderson shelter during the raid on August 18 when five bombs fell within a distance of 100 yards. "Our little shelter trembled," he said, "but we suffered no shock and no damage, though our windows were broken." On the other hand, people in an Anderson shelter in the South-Western suburbs were injured by bomb splinters penetrating the back of the shelter, which was not completely covered with earth.

A CRATER, 25 FT. DEEP, OUTSIDE A DAMAGED HOUSE IN CROYDON. ALL THE OCCUPANTS OF THE SHELTERS ESCAPED INJURY. *(Topical.)*

HARDLY THE "COWERING" LONDONERS OF DR. GOEBBELS' IMAGINATION: A CHEERFUL NORTHFLEET FAMILY SITTING BY THEIR SHELTER AFTER A RAID. *(Fox.)*

AN UNDAUNTED MIDLAND FAMILY, DUG OUT AFTER A BOMB HAD BURST BEHIND THEIR SHELTER—WHICH SAVED THEM. *(A.P.)*

MR. AND MRS. SHERMAN, OF CROYDON, WITH THEIR BABY, BY THEIR SHELTER, ON EACH SIDE OF WHICH BOMBS BURST. *(G.P.U.)*

GIVING THE LIE TO GOEBBELS: MRS. E. CULLEN SMILINGLY LEAVING THE EMERGENCY EXIT—A BOMB HAVING BLOCKED THE SHELTER ENTRANCE. *(Planet.)*

15 Sept 1940: Anderson shelter occupants survived air raid, Ransome Way, Liverpool

Anderson shelter occupants survive air raid destruction at Purfleet

17 June 1944: Anderson shelter absorbs blast from V1 at Elsenham Rd, East End, London

Family survive without injury in wrecked Anderson shelter (note earth blown off) during London Blitz in 1940. Damage to the shelter absorbed the blast energy.

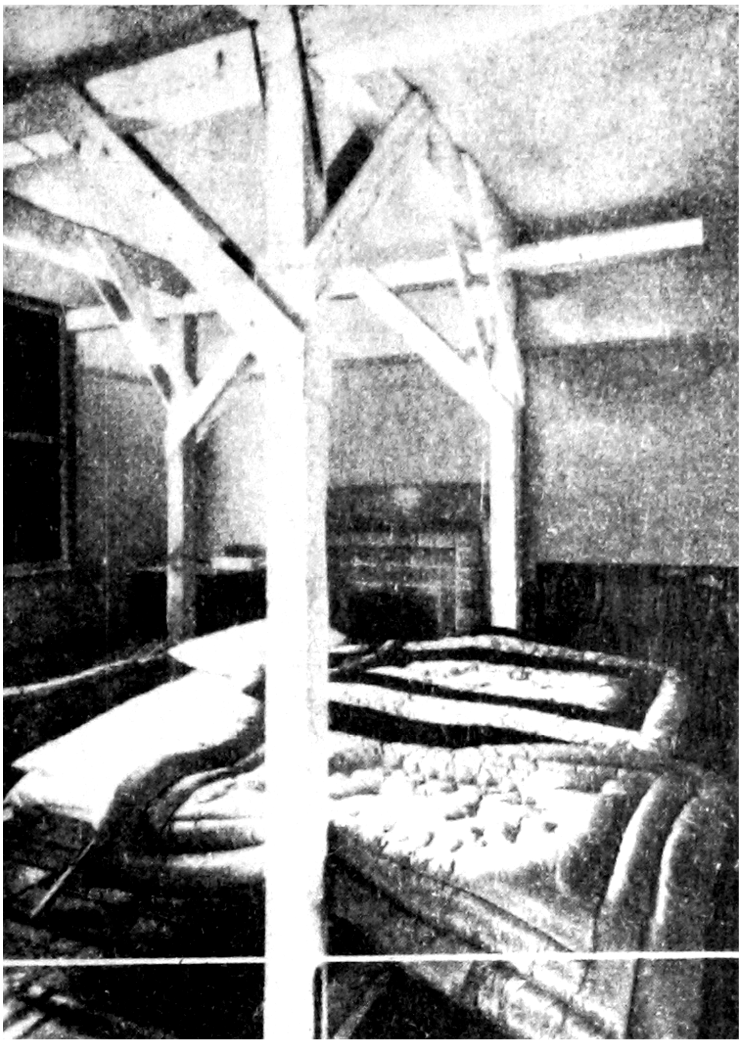
28 Jan 1945: Priory Road, East Ham

27 April 1944: Anderson shelter occupants survive at Forest Drive, East End, London

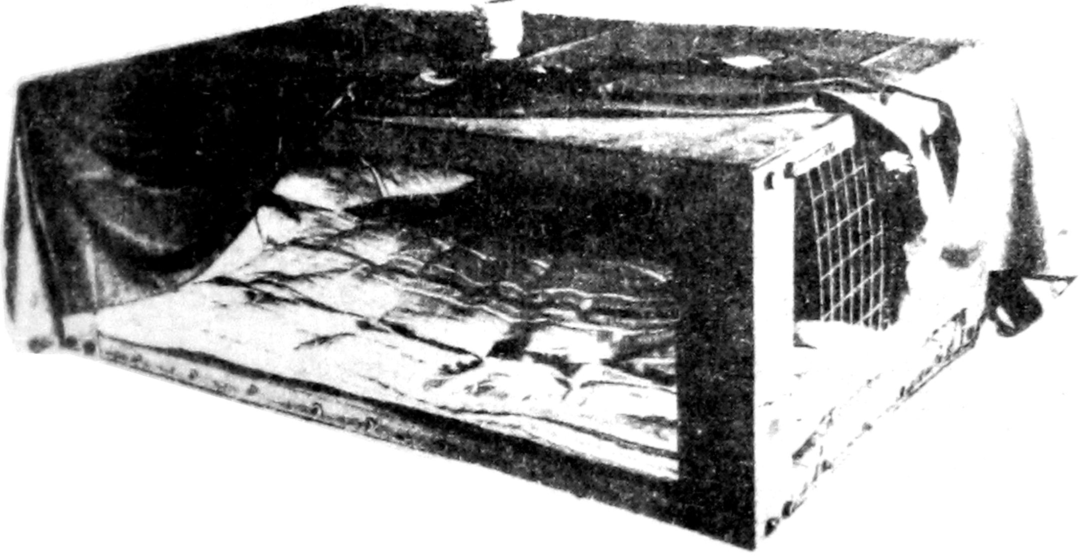
10 July 1944: Anderson shelter occupants survive air raid at Harcourt Avenue, East End, London

17 July 1944: Anderson shelter occupants survive at Tennyson Ave, Plashet Grove

June 1941



# SHELTER at home



3d. ISSUED BY THE MINISTRY OF HOME SECURITY AND PUBLISHED BY H.M. STATIONERY OFFICE

## Introduction

Not everyone wants to leave home for shelter. Some people can't. Lots of people just prefer to remain in their own house anyway. This inclination is a natural one. It is a sound instinct too, if some protection can be found against the collapse of walls and ceilings.

Shelter indoors allows you to sleep at night in reasonable security and in the warmth and comfort of your house. It also provides handy cover should there be a sudden raid in the day time.

A direct hit cannot be guarded against in any form of home shelter, but the risk of such a direct hit is very small compared with that of a bomb bursting near enough to damage the house or to demolish it. Protection can be obtained in a house even if a bomb demolishes most of it.

The walls, floors and roof of an ordinary house give quite a lot of protection against splinters and blast from a bomb. The idea of an indoor shelter is to make use of this protection and to add safeguards against the other effects of bombs.

The chief of these is the danger of the house falling down. People have often been rescued unhurt from the ruins of demolished houses because they had taken shelter under staircases, or tables, that had by chance been strong enough to protect them from the falling ruins of the house. The chief purpose of the indoor shelters described in this pamphlet is to protect the occupants against injury when the bedroom floor, the roof and other débris fall on them.

They do not provide such easy emergency escape as a garden shelter, but if you are trapped they protect you from the débris till the Rescue Party releases you. Very often, however, though the house has fallen you will be able to release yourself and walk out.

The indoor shelters with which this pamphlet deals are unsuitable for houses with more than two storeys above the shelter room. They are intended chiefly for use in ordinary two-storey houses, but have a margin of strength that will take the weight of an extra storey.

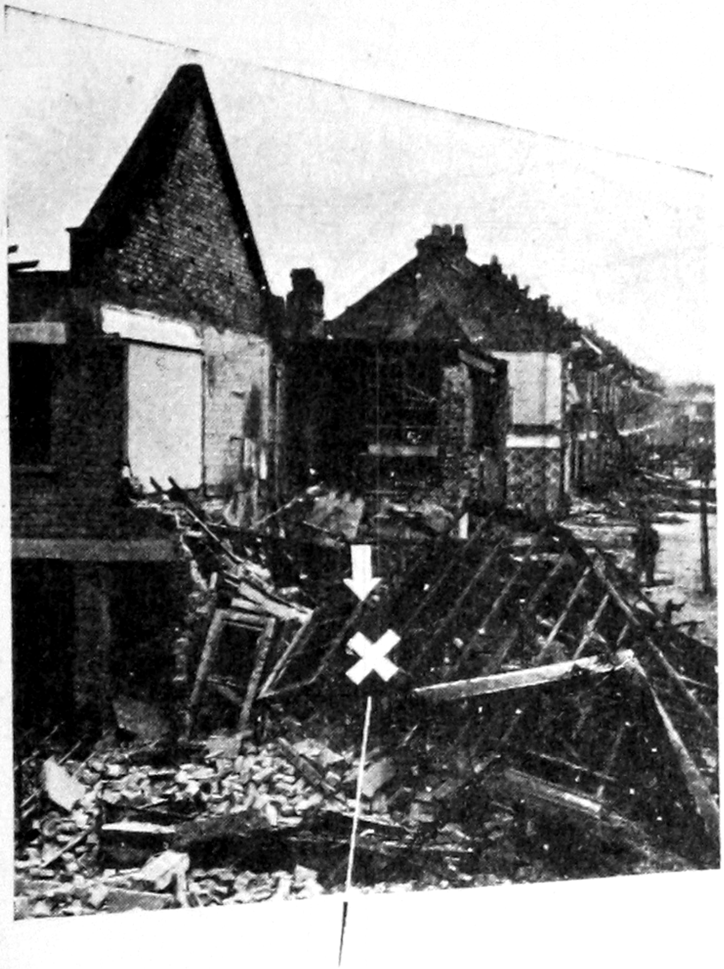
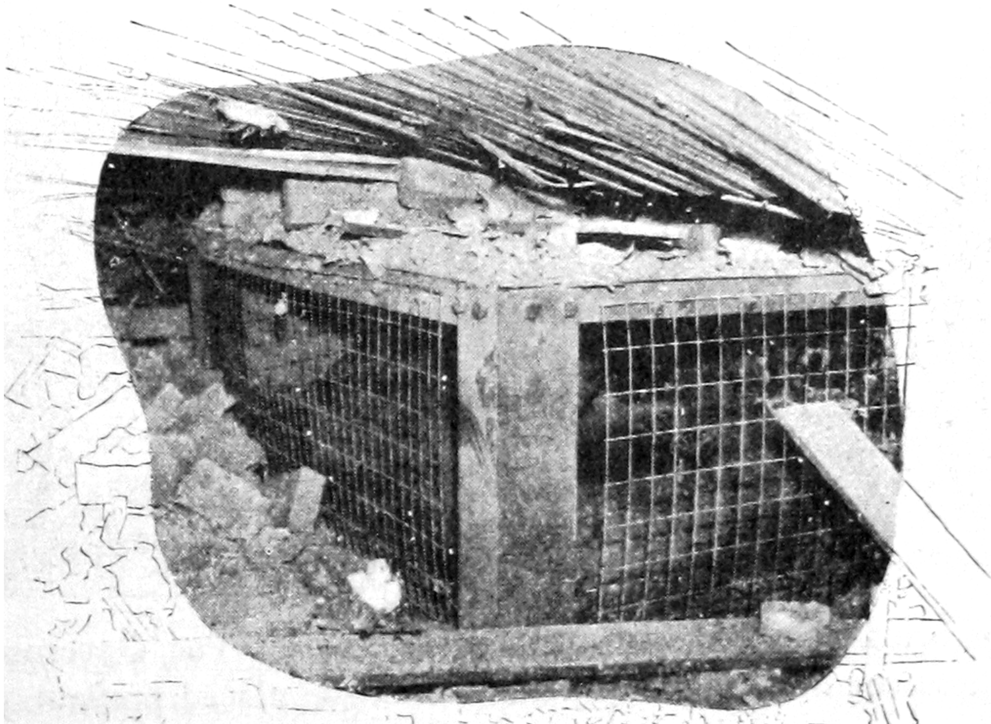


ILLUSTRATION NO. 8.

The house in the upper photograph had a Government steel table shelter in a downstairs room and was blown up to reproduce the effect of a heavy bomb falling near. The whole house collapsed, burying the shelter under débris. In the lower photo the shelter can be seen still intact. It would have been possible for anyone in the shelter to get out unaided.



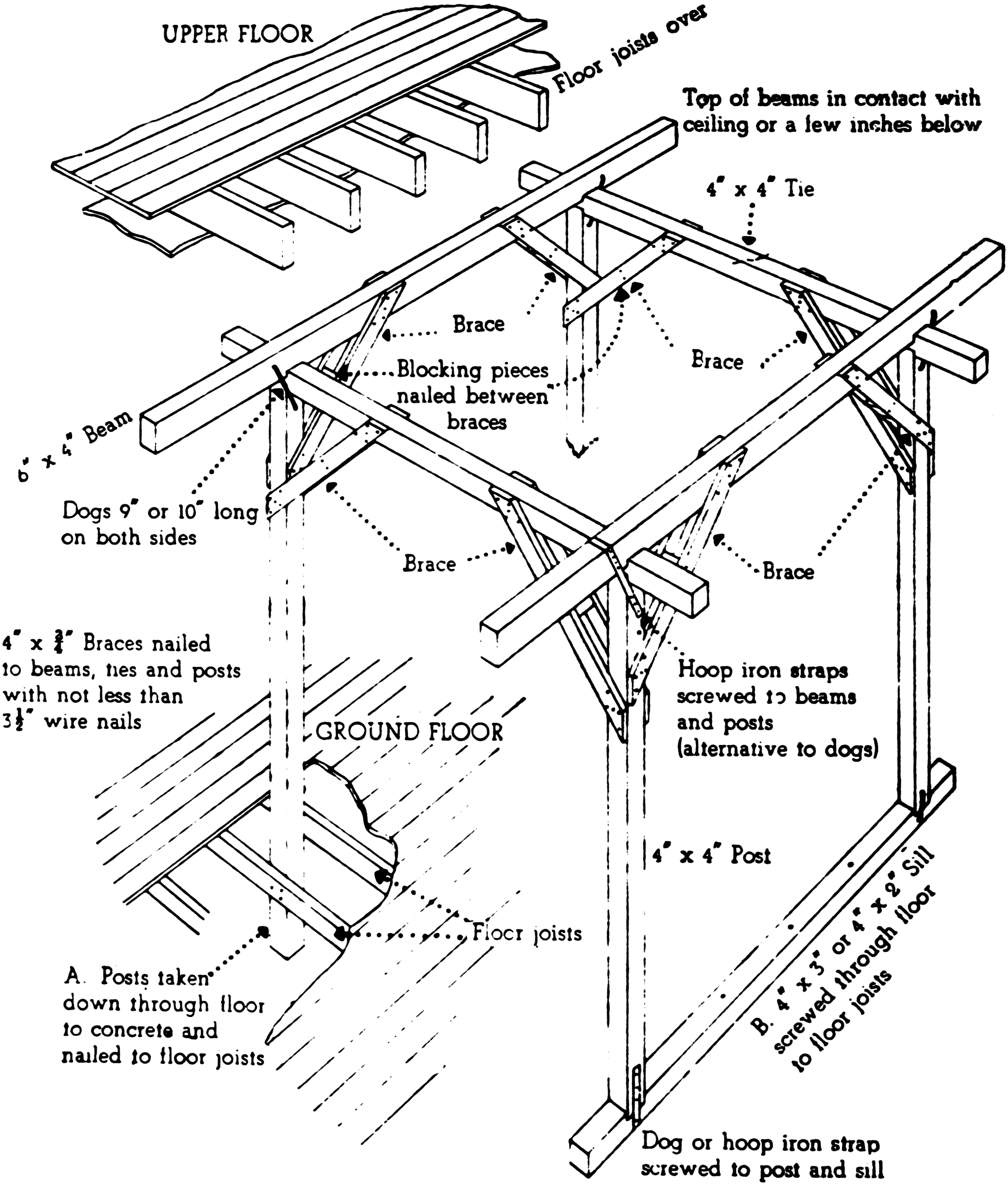
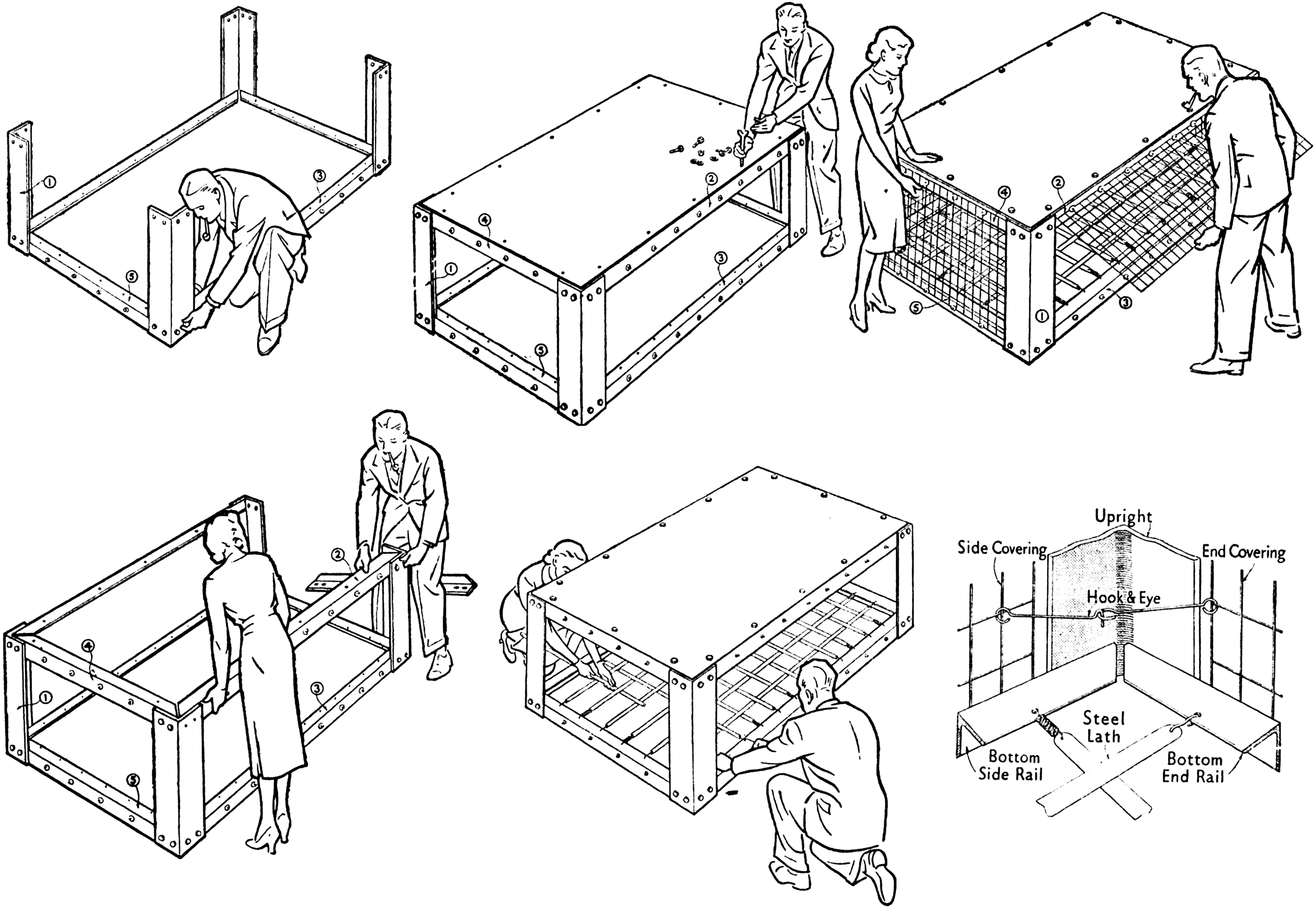



ILLUSTRATION NO. 11. Independent timber framework for a refuge room. If the posts are more than 6 ft. 6 in. apart, 8 in. × 4 in. beams are desirable.

## A home-made shelter

You will have noticed earlier in this booklet the statement that people have often been rescued from demolished houses because they had taken shelter under an ordinary table. This was because the table had by chance been strong enough to bear the weight of the falling bedroom floor. A timber framework can be built inside a refuge room to do the same thing, but with certainty. ILLUSTRATION NO. 11 shows a completed framework




How to Put Up Your "Morrison" Steel Table Shelter, 1942

Structural Defense, 1945, by D. G. Christopherson, Ministry of Home Security, RC 450, (1946); Chapters VIII and IX (Confidential). Chapter VIII summarizes the literature on the design and types of British shelters and analyzes their effectiveness.

National Archives
HO 195/16

**November 1940 design by C. A. Joy, M. Inst. Me. & C. E., Bexley Borough Engineer (UK National Archives: HO 205/257)**

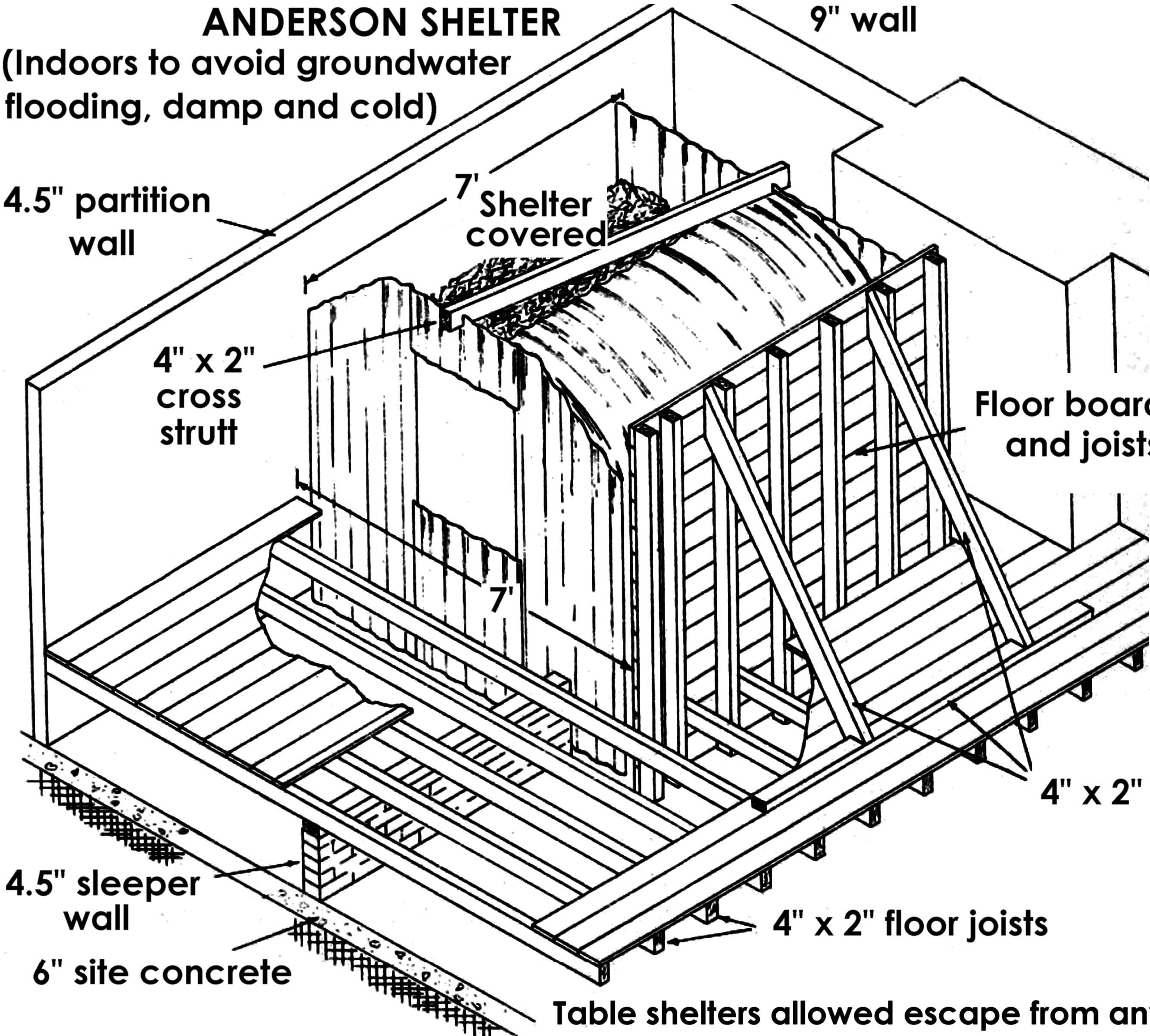
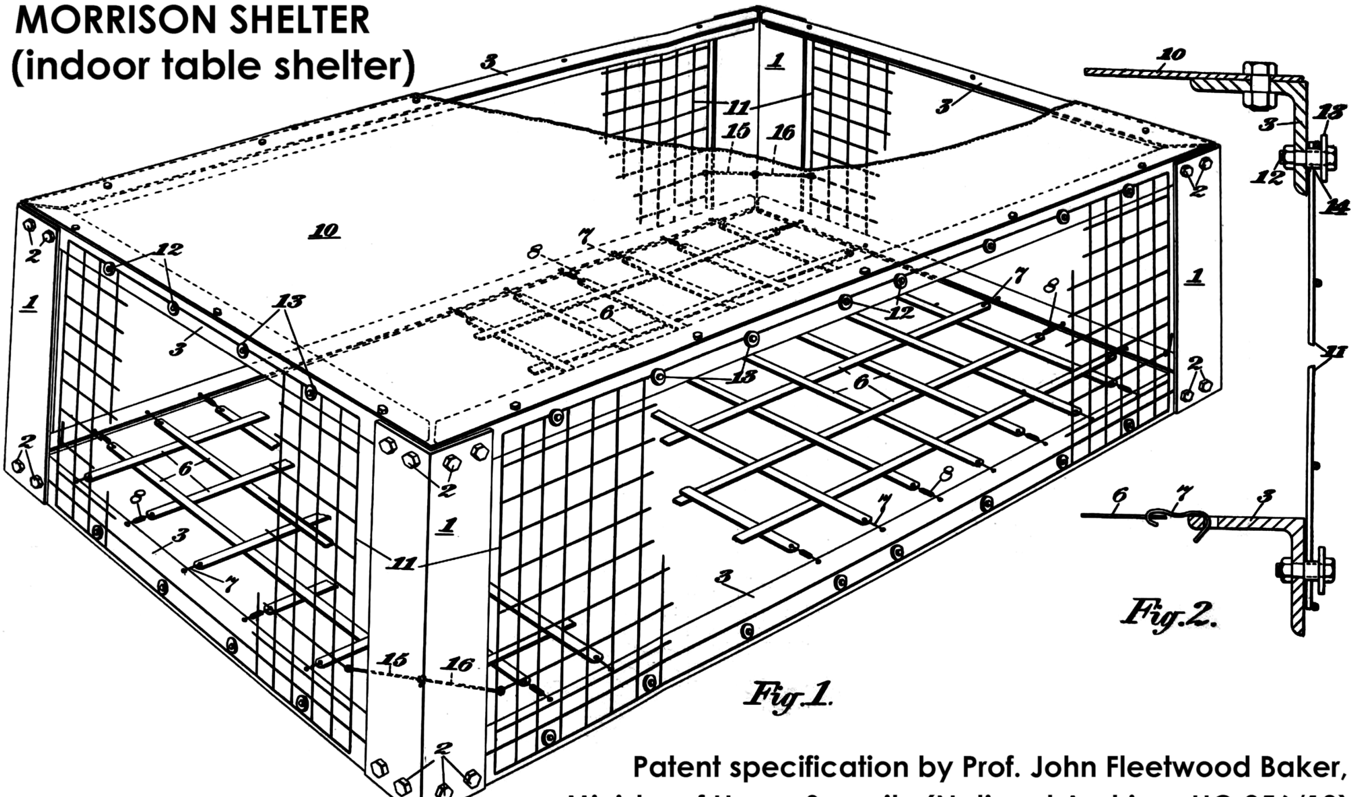



Table shelters allowed escape from any side easily, reducing fire risks

**MORRISON SHELTER**
**(indoor table shelter)**




Patent specification by Prof. John Fleetwood Baker, Ministry of Home Security (National Archives HO 356/10)

ILLUSTRATION NO. 8.

The house in the upper photograph had a Government steel table shelter in a downstairs room and was blown up to reproduce the effect of a heavy bomb falling near. The whole house collapsed, burying the shelter under débris. In the lower photo the shelter can be seen still intact. It would have been possible for anyone in the shelter to get out unaided.

(Page 11 from the June 1941 UK Ministry of Home Security "Shelter at Home" handbook.)

SECRET.

W.P.(G)(41)7. COPY NO. 62

January 15th, 1941.

# WAR CABINET.

## AIR RAID SHELTER POLICY.

Memorandum by the Minister of Home Security.

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6. Shelter in the home: The Anderson shelter was originally intended for indoor use but for a number of reasons including the danger of fire an outdoor variant was adopted. Experience has shown that the objections to the indoor use of the Anderson or somewhat similar shelter are not so serious as was thought and two designs have been produced which can be erected indoors without support. These new types, although they may give slightly less protection than a well covered Anderson shelter out of doors, would fill the needs of a large section of the public, especially the middle class. One design allows the use of the shelter as part of the furniture of the room.

7. I regard shelters of this type as of the first importance and wish to provide them on a big scale. Each shelter will use over 3 cwt. of steel and will allow at a pinch two adults and one to two children to sleep inside. For an outlay of about 65,000 tons of steel, as a first instalment, I could therefore produce 400,000 shelters with accommodation for at least 1,000,000 persons. I should wish to complete such a programme within the first three months of production and thereafter at a similar or increasing rate. From enquiries I believe that manufacture can be arranged provided steel is supplied and if the Cabinet approves my policy I shall require their direction that the steel be made available.

10. Conclusions.

I ask for a general endorsement of the policy I have outlined in this paper and in particular for the agreement of my colleagues:

(i) that proposals for building shelters of massive construction should be rejected;

(ii) that steel should be made available to carry out the programme outlined in paragraph 7 for the provision of steel shelters indoors;

(iii) that the limit of income for the provision of free shelter for insured persons should be raised from £250 to £350 per annum.

H.M.

MINISTRY OF HOME SECURITY.
January 15th, 1941.

# Morrison Shelters in Recent Air Raids.

A report of Ministry of Home Security experts on 39 cases of bombing incidents in different parts of Britain covering all those for which full particulars are available in which Morrison shelters were involved shows how well they have stood up to severe tests of heavy bombing.

All the incidents were serious. Many of the incidents involved direct hits on the houses concerned a risk against which it was never claimed these shelters would afford protection. In all of them the houses in which shelters were placed were within the radius of damage by bombs; in 24 there was complete demolition of the house on the shelter.

A hundred and nineteen people were sheltering in these "Morrisons" and only four were killed. So that 115 out of 119 people were saved. Of these only 7 were seriously injured and 14 slightly injured while 94 escaped uninjured. The majority were able to leave their shelters unaided.

Morrison shelter saves lives of Mr McGregor pictured beside Morrison shelter, as well as his wife and lodger, in collapsed house, York 1942 air raid

Morrison indoor table shelter test by Ministry of Home Security, 1941: result shelter survived and occupants would have escaped unaided. (Source: "Shelter at Home", June 1941 handbook.)

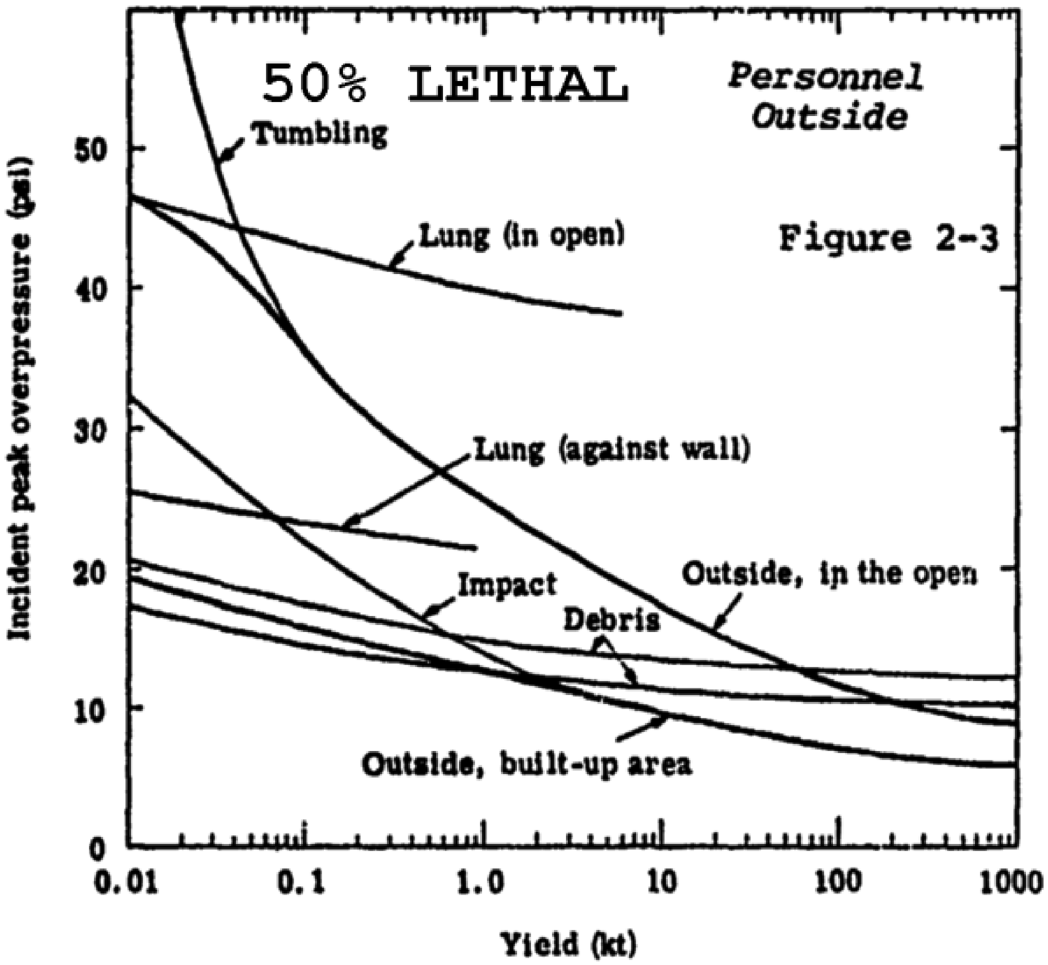
Morrison shelter saves lives of Mr McGregor (pictured beside Morrison shelter), as well as his wife and lodger, in collapsed house, York 1942 air raid

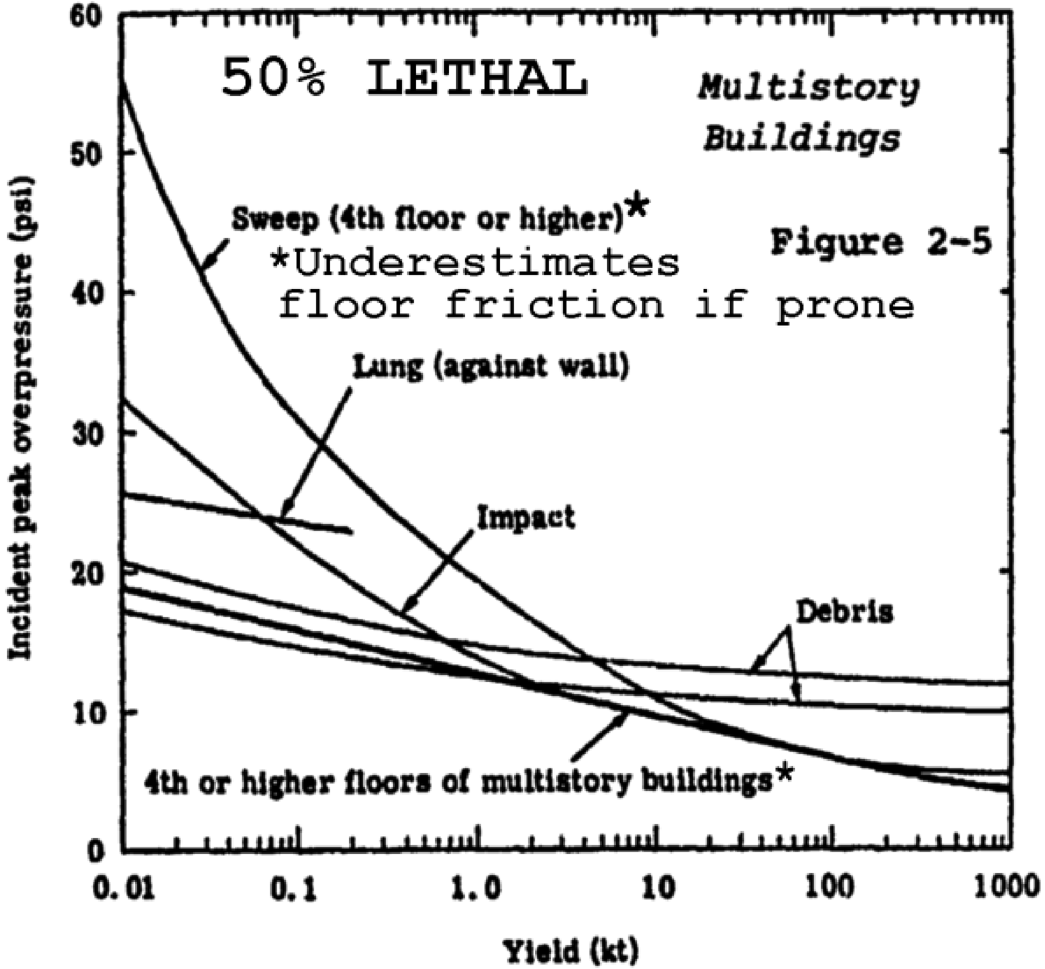
UK National Archives: HO 192/909

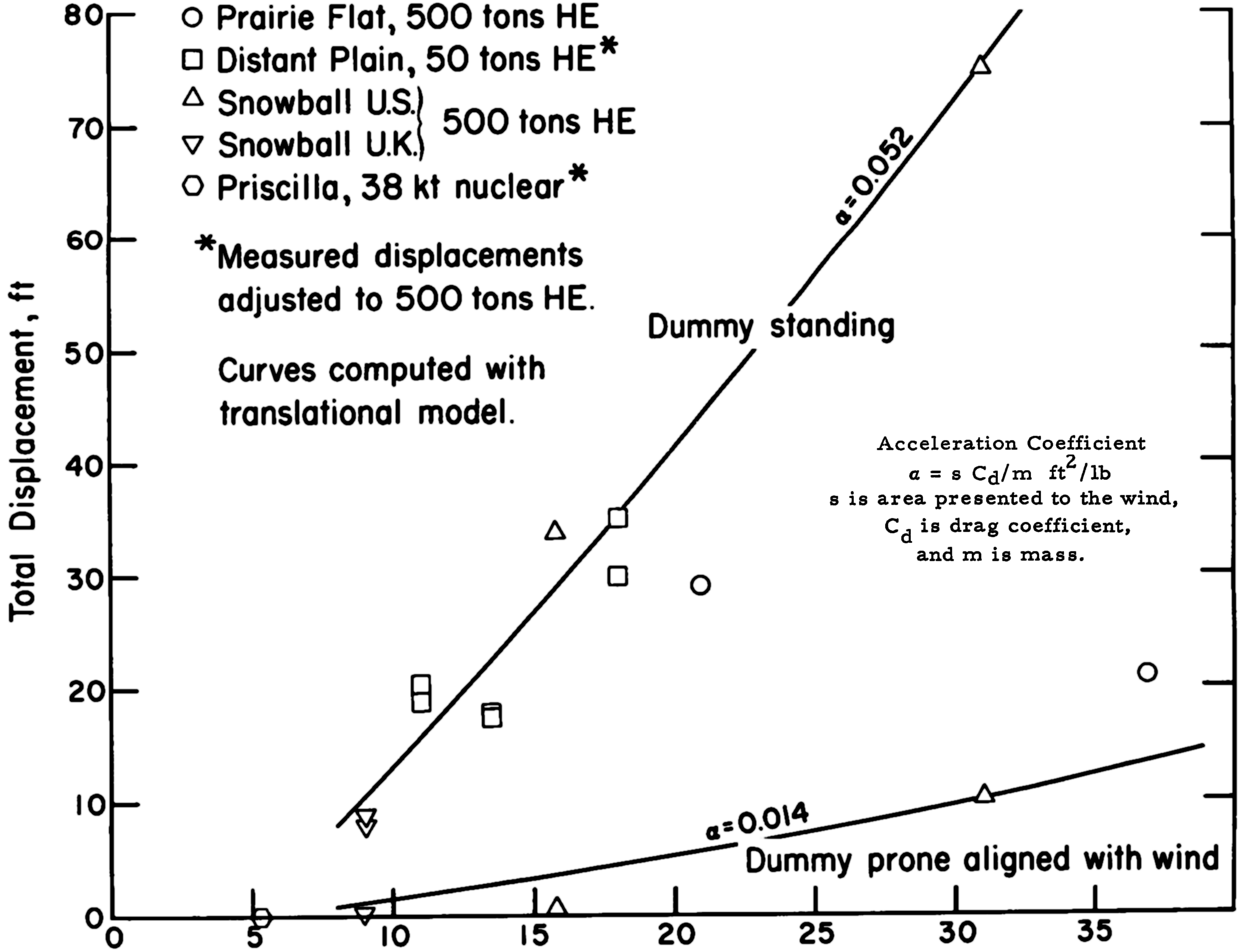
Morrison shelter surviving 250 kg direct hit on 12 March 1943 on house at 10 Fore Street, Salcombe (Mrs Hannaford)

WWII Surface shelter (UK National Archives INF 13/218)

Dr Martin P. Fricke (Science Applications International Corp., California), "Preliminary Civilian Casualty Criteria for Low-Yield Nuclear Weapons," DNA-3547T, 1975.





80
70
60
50
40
30
20
10
0
Total Displacement, ft
Prairie Flat, 500 tons HE
Distant Plain, 50 tons HE*
Snowball U.S.
Snowball U.K.
500 tons HE
Priscilla, 38 kt nuclear*
*Measured displacements adjusted to 500 tons HE.
Curves computed with translational model.
α=0.052
Dummy standing
Acceleration Coefficient
α = s Cd/m ft2/lb
s is area presented to the wind,
Cd is drag coefficient,
and m is mass.
α=0.014
Dummy prone aligned with wind
0
5
10
15
20
25
30
35
Peak Overpressure, psi

# *The Effects of*

# Nuclear Weapons


SAMUEL GLASSTONE
*Editor*



*Revised Edition*
*Reprinted February 1964*

*Prepared by the*
UNITED STATES DEPARTMENT OF DEFENSE
*Published by the*
UNITED STATES ATOMIC ENERGY COMMISSION
April 1962

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price $3.00 (paper bound)

# Foreword

This book is a revision of "The Effects of Nuclear Weapons" which was issued in 1957. It was prepared by the Defense Atomic Support Agency of the Department of Defense in coordination with other cognizant governmental agencies and was published by the U.S. Atomic Energy Commission. Although the complex nature of nuclear weapons effects does not always allow exact evaluation, the conclusions reached herein represent the combined judgment of a number of the most competent scientists working on the problem.

There is a need for widespread public understanding of the best information available on the effects of nuclear weapons. The purpose of this book is to present as accurately as possible, within the limits of national security, a comprehensive summary of this information.

Robert S. McNamara

Secretary of Defense

Glenn T. Seaborg

Chairman
Atomic Energy Commission

# BASIS FOR PROTECTIVE ACTION

12.11 In Japan, where little evasive action was taken, the survival probability depended upon whether the individual was outdoors or inside a building and, in the latter case, upon the type of structure. At distances between 0.3 and 0.4 mile (530 and 700 yards) from ground zero in Hiroshima the average survival rate, for at least 20 days after the nuclear explosion, was less than 20 percent. Yet in two reinforced-concrete office buildings, at these distances, almost 90 percent of the nearly 800 occupants survived more than 20 days, although some died later from radiation injury.

These facts bring out clearly the greatly improved chances of survival from a nuclear explosion that could result from the adoption of suitable warning and protective measures.

TABLE 12.29—ARRIVAL TIME FOR PEAK OVERPRESSURE

| *Distance (miles)* | *Explosion yield* | | | | |
|---|---|---|---|---|---|
| | *1 KT* | *10 KT* | *100 KT* | *1 MT* | *10 MT* |
| | | | *(Time in seconds)* | | |
| 1 | 4. 3 | 3. 6 | 3. 7 | 2. 5 | 1. 5 |
| 2 | 9 | 8. 1 | 7. 4 | 6. 5 | 5. 0 |

12.35. The major part of the thermal radiation travels in straight lines, and so any opaque object interposed between the fireball and the exposed skin will give some protection. This is true even if the object is subsequently destroyed by the blast, since the main thermal radiation pulse is over before the arrival of the blast wave.

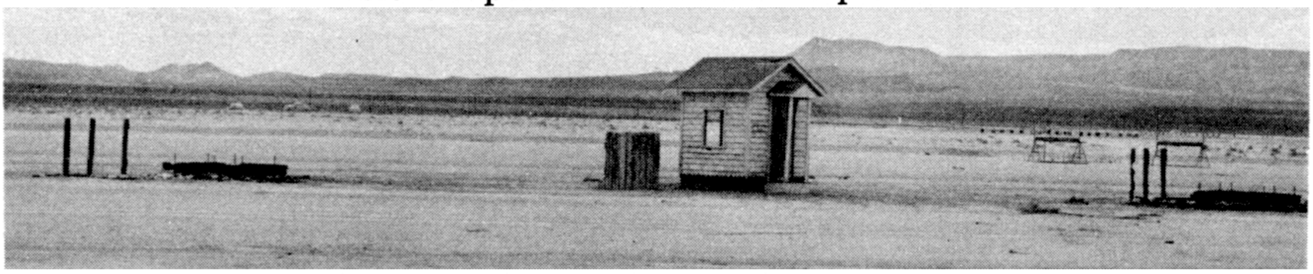
12.36 At the first indication of a nuclear explosion, by a sudden increase in the general illumination, a person inside a building should immediately fall prone, as described in § 12.30, and, if possible, crawl behind or beneath a table or desk or to a planned vantage point.

12. 72 Because of its particulate nature, fallout will tend to collect on horizontal surfaces, e.g., roofs, streets, tops of vehicles, and the ground. In the preliminary decontamination, therefore, the main effort should be directed toward cleaning such surfaces. The simplest way of achieving this is by water washing, if an adequate supply of water is available. The addition of a commercial wetting agent (detergent) will make the washing more efficient. The radioactive material is thus tranferred to storm sewers where it is less of a hazard.

Nevada in 1953.

12 calories per square centimeter


before exposure to a nuclear explosion

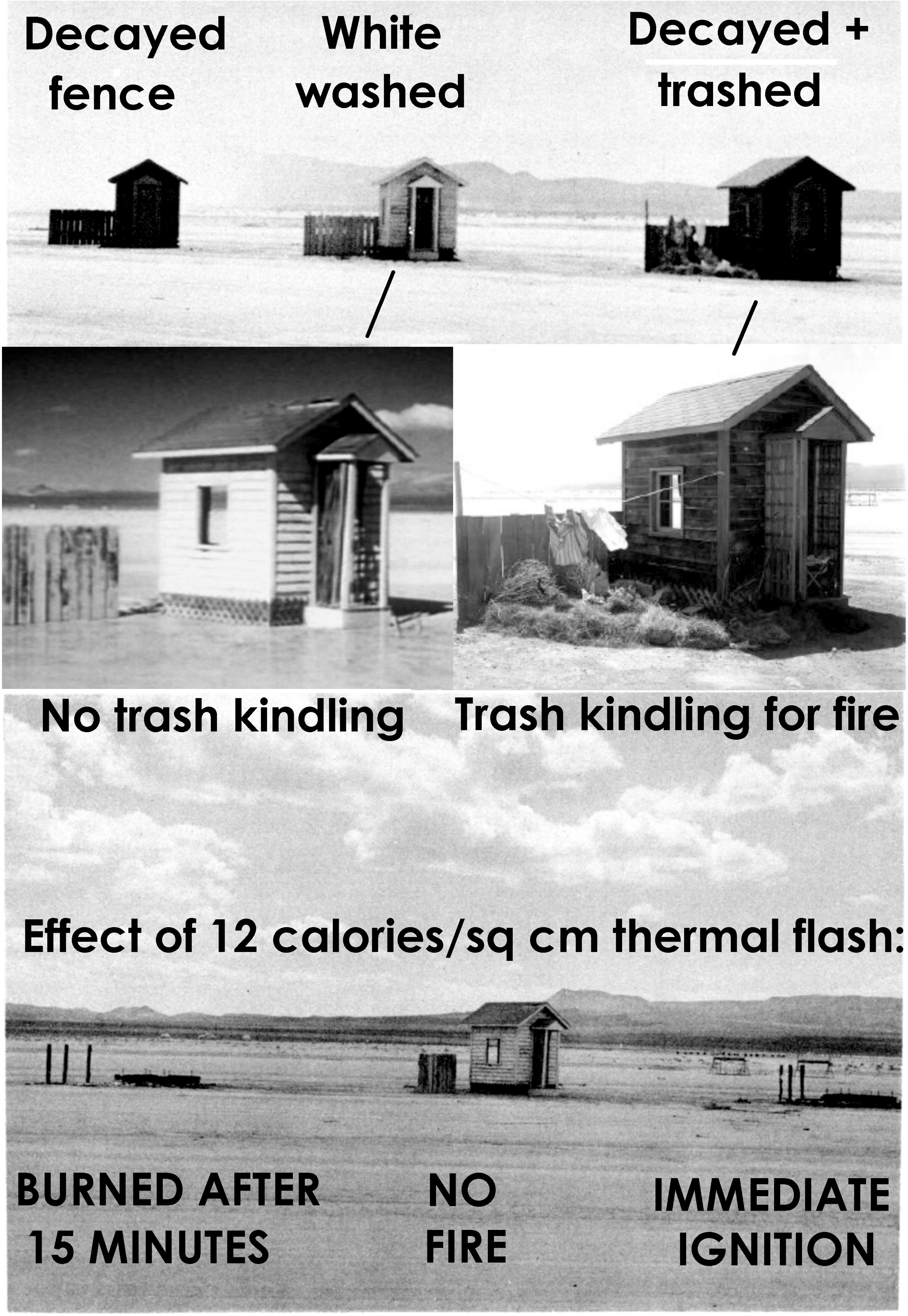


after exposure to a nuclear explosion

7.59 The value of fire-resistive furnishing in decreasing the number of ignition points was also demonstrated in the tests. Two identical, sturdily constructed houses, each having a window 4 feet by 6 feet facing the point of burst, were erected where the thermal radiation exposure was 17 calories per square centimeter. One of the houses contained rayon drapery, cotton rugs, and clothing, and, as was expected, it burst into flame immediately after the explosion and burned completely. In the other house, the draperies were of vinyl plastic, and rugs and clothing were made of wool. Although much ignition occurred, the recovery party, entering an hour after the explosion, was able to extinguish the fires.

7.76 It should be noted that the fire storm is by no means a special characteristic of nuclear weapons. Similar fire storms have been reported as accompanying large forest fires in the United States, and especially after incendiary bomb attacks in both Germany and Japan during World War II. The high winds are produced largely by the updraft of the heated air over an extensive burning area. They are thus the equivalent, on a very large scale, of the draft of a chimney under which a fire is burning. Because of limited experience, the conditions for the development of fire storms in cities are not well known. It appears, however, that some, although not necessarily all, of the essential requirements are the following: (1) thousands of nearly simultaneous ignitions over an area of at least a square mile, (2) heavy building density, e.g., more than 20 percent of the area is covered by buildings, and (3) little or no ground wind. Based on these criteria, only certain sections—usually the older and slum areas—of a very few cities in the United States would be susceptible to fire storm development.

**Weapon test report WT-775, Project 8.11b, ENCORE nuclear test, Nevada, 1953:**




**6' x 6' wood frame houses**

CONFIDENTIAL

Classification (~~Confidential~~) Changed to ~~..~~
By Authority of Memo, Ch. Security Div. 8-20-57
By G. Hamos / Ca ------- Date OCT 24 1957

# HANDBOOK

# on

# CAPABILITIES

# of

# ATOMIC WEAPONS



[redacted]

CONFIDENTIAL

## 10.3 Damage Criteria

10.32 For those items not included in Table VIII, select the listed item most similar in those characteristics discussed previously as being the important factors in determining the extent of damage to be expected. Perhaps the most important item to be remembered when estimating effects on personnel is the amount of cover actually involved. This cover depends on several items; however, one factor is all important, namely, the degree of forewarning of an impending atomic attack. It is obvious that only a few seconds warning is necessary under most conditions in order to take fairly effective cover. The large number of casualties in Japan resulted for the most part from the lack of warning.

TABLE VIII

| ITEM | DAMAGE | AIR SHOCK PSI | REMARKS |
|---|---|---|---|
| Artillery Field (75mm or greater) | Severe | 40 | Damage to Gun and Cradle |
| | Moderate | 30 | Damage to Recoil and Carriage |
| | Light | 5 | Damage to Gun Sights |
| Artillery Field (Less than 75mm) | Severe | 25 | Damage to Gun and Cradle |
| | Moderate | 15 | Damage to Recoil and Loading Mechanism |
| | Light | 5 | Damage to Sights |
| Reinforced Concrete Bldgs. | Severe | 25 | Collapse |
| | Moderate | 10 | Structural damage |
| | Light | 3 | Plaster & window damage |
| Steel, heavy frame Bldgs. | Severe | 18 | Mass distortion |
| | Moderate | 12 | Structural Damage |
| | Light | 3 | Plaster & window damage |
| Steel, light frame Bldgs. | Severe | 10 | Mass distortion |
| | Moderate | 5 | Structural Damage |
| | Light | 3 | Plaster & window damage |

# FM 101-31-3

DEPARTMENT OF THE ARMY FIELD MANUAL

## STAFF OFFICERS FIELD MANUAL

# NUCLEAR WEAPONS EMPLOYMENT


HEADQUARTERS, DEPARTMENT OF THE ARMY

FEBRUARY 1963

# ATOMIC DEMOLITION MUNITIONS

## on the surface

### SEVERE DAMAGE RADII—METERS

| *Materiel classification* | *Yield—KT* | | | | | |
|---|---|---|---|---|---|---|
| | *ALFA/ .5* | *BRAVO/ 1* | *DELTA/ 5* | *ECHO/ 10* | *GOLF/ 50* | *HOTEL/ 100* |
| Tunnels and mines<br>Heavy masonry or concrete dams and bridges | 50 | 50 | 125 | 175 | 225 | 300 |
| Tanks and artillery<br>Locomotives<br>Supply depots<br>Engineer earthmoving equip<br>Field fortifications | 75 | 100 | 175 | 250 | 450 | 600 |
| Engineer truck-mounted equip<br>Earth-covered surface shelters<br>Blast-resistant reinforced concrete bldgs | 100 | 100 | 200 | 250 | 400 | 525 |
| Military vehicles<br>Railroad cars<br>Communications equip<br>Truss and floating bridges<br>Monumental-type multistory wall-bearing bldgs<br>Heavy steel frame industrial bldgs<br>Multistory, reinforced concrete frame bldgs | 150 | 200 | 375 | 500 | 950 | 1,250 |
| Oil storage tanks<br>Multistory, reinforced concrete bldgs (small window area)<br>Multistory, steel frame office bldgs<br>Light steel frame industrial bldgs | 250 | 300 | 475 | 650 | 1,125 | 1,425 |
| Multistory, wall-bearing bldgs (apt house type)<br>Parked combat aircraft | 375 | 450 | 800 | 1,000 | 1,700 | 2,125 |
| Wood frame bldgs | 375 | 650 | 1,050 | 1,325 | 2,275 | 2,875 |

*Figure 12.1.*

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DEPARTMENT OF THE ARMY TECHNICAL MANUAL — TM 23-200
DEPARTMENT OF THE NAVY — OPNAV INSTRUCTION 03400.1B
DEPARTMENT OF THE AIR FORCE — AFL 136-1
MARINE CORPS PUBLICATIONS — NAVMC 1104 REV

# CAPABILITIES OF ATOMIC WEAPONS (U)

**Prepared by**
**Armed Forces Special Weapons Project**

**DEPARTMENTS OF THE ARMY, THE NAVY AND THE AIR FORCE**

***REVISED EDITION NOVEMBER 1957***

~~CONFIDENTIAL~~

*Personnel in structures.* A major cause of personnel casualties in cities is structural collapse and damage. The number of casualties in a given situation may be reasonably estimated if the structural damage is known. Table 6–1 shows estimates of casualty production in two types of buildings for several damage levels. Data from Section VII may be used to predict the ranges at which specified structural damage occurs. Demolition of a brick house is expected to result in approximately 25 percent mortality, with 20 percent serious injury and 10 percent light injury. On the order of 60 percent of the survivors must be extricated by rescue squads. Without rescue they may become fire or asphyxiation casualties, or in some cases be subjected to lethal doses of residual radiation. Reinforced concrete structures, though much more resistant to blast forces, produce almost 100 percent mortality on collapse. The figures of table 6–1 for brick homes are based on data from British World War II experience. It may be assumed that these predictions are reasonably reliable for those cases where the population is in a general state of expectancy of being subjected to bombing and that most personnel have selected the safest places in the buildings as a result of specific air raid warnings. For cases of no prewarning or preparation, the number of casualties is expected to be considerably higher.

6–2

Glass breakage extends to considerably greater ranges than almost any other structural damage, and may be expected to produce large numbers of casualties at ranges where personnel are relatively safe from other effects, particularly for an unwarned population.

*Table 6–1. Estimated Casualty Production in Structures for Various Degrees of Structural Damage*

| | Killed outright | Serious injury (hospitalization) | Light injury (No hospitalization) |
|---|---|---|---|
| 1–2 story brick homes (high explosive data): | *Percent* | *Percent* | *Percent* |
| Severe damage | 25 | 20 | 10 |
| Moderate damage | <5 | 10 | 5 |
| Light damage | ...... | <5 | <5 |

*Note.* These percentages do not include the casualties which may result from fires, asphyxiation, and other causes from failure to extricate trapped personnel. The numbers represent the estimated percentage of casualties expected at the maximum range where the specified structural damage occurs.

Personnel in a prone position are less likely to be struck by flying missiles than those who remain standing.

6–3

*Table 6–2. Critical Radiant Exposures for Burns Under Clothing*

*(Expressed in cal/cm² incident on outer surface of cloth)*

| Clothing | Burn | 1 KT | 100 KT | 10 MT |
|---|---|---|---|---|
| Summer Uniform | 1° | 8 | 11 | 14 |
| (2 layers) | 2° | 20 | 25 | 35 |
| Winter Uniform | 1° | 60 | 80 | 100 |
| (4 layers) | 2° | 70 | 90 | 120 |

6–4

## 3.1 General

For a surface burst having the same yield as an air burst, the presence of the earth's surface results in a reduced thermal radiation emission and a cooler fireball when viewed from that surface. This is due primarily to heat transfer to the soil or water, the distortion of the fireball by the reflected shock wave, and the partial obscuration of the fireball by dirt and dust (or water) thrown up by the blast wave.

~~CONFIDENTIAL~~ 3–1

Measurements from the ground of the total thermal energy from surface bursts, although not as extensive as those for air bursts, indicate that the thermal yield is a little less than half that from equivalent air bursts. For a surface burst the thermal yield is assumed to be one-seventh of the total yield.

3–2 ~~CONFIDENTIAL~~

$$Q=\frac{3.16\times10^6\ W\ (\overline{T})}{D^2}\ \text{cal/sq cm (air burst).}$$

and

$$Q=\frac{1.35\times 10^6\ W\ (\overline{T})}{D^2}\ \text{cal/sq cm (surface burst).}$$

where $Q$=radiant exposure (cal/sq cm)
$\overline{T}$=atmospheric transmissivity
$W$=weapon yield (KT)
$D$=slant range (yds).

~~CONFIDENTIAL~~ 3–3

The differences between the air burst and surface burst curves are caused by the difference in apparent radiating temperatures (when viewed from the ground) and the difference in geometrical configuration of the two types of burst.

50 mile visibility and 5 gm/m³ water vapor.
10 mile visibility and 10 gm/m³ water vapor.

## 3.3 Radiant Exposure vs. Slant Range

*a. Spectral. Characteristics.* At distances of operational interest, the spectral (wavelength) distribution of the incident thermal radiation, integrated with respect to time, resembles very closely the spectral distribution of sunlight. For each, slightly less than one-half of the radiation occurs in the visible region of the spectrum, approximately one-half occurs in the infrared region and a very small fraction (rarely greater than 10 percent) lies in the ultraviolet region of the spectrum. The color temperature of the sun and an air burst are both about 6,000° K. A surface burst, as viewed by a ground observer, contains a higher proportion of infrared radiation and a smaller proportion of visible radiation than the air burst, with almost no radiation in the ultraviolet region. The color temperature for a surface burst is about 3,000° K. A surface burst viewed from the air may exhibit a spectrum more nearly like an air burst.

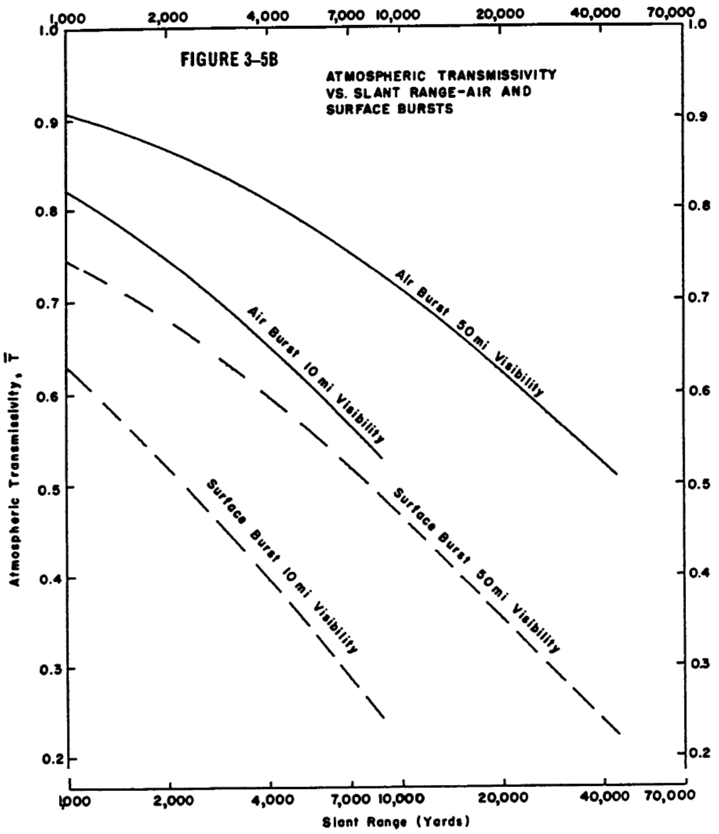



*Table 12–2. Critical Radiant Exposure Values for Various Materials*

| Material | Damage | Critical radiant exposure $Q_c$ (cal/sq cm) | | |
|---|---|---|---|---|
| | | 1 KT | 100 KT | 10 MT |
| Sandbags: Cotton canvas, dry, filled | Failure | 10 | 18 | 32 |
| Wood, white pine | 0.1 mm depth char | 10 | 18 | 32 |
| White pine, given protective coating | 0.1 mm depth char | 40 | 71 | 126 |

# SECTION VII
# DAMAGE TO STRUCTURES

## 7.1 General

Tunnels in solid rock are difficult to destroy by explosions of nuclear weapons. In this case, the shock wave is transmitted through the rock. When it reaches the tunnel the wave is reflected as a tensile wave, and there is a tendency for the rock to spall or become detached from the rock-tunnel interface. Use of tunnel linings materially reduces this spalling. Mass crushing of the rock and filling of the tunnel occurs closer to the burst point.

## 7.4 Field Fortifications

*a. Air Blast.* Air blast is the controlling damage-producing mechanism for destruction of field fortifications, including those reinforced, revetted or covered. Definitions of severe, moderate, and light damage levels to various types of field fortifications are given in table 7–4. These damage levels are based upon various degrees of collapse and structural failure except for unrevetted trenches and foxholes, which have damage levels based on degree of filling caused by collapse of the walls and by filling with dust and debris. Areas covered with loose material, such as sand and gravel, may provide sufficient dust and debris to completely fill a trench or foxhole, whereas areas with stable vegetation or areas of dry silty soil may not provide significant quantities of dust and debris to appreciably fill a trench or foxhole. Collapse of the walls of foxholes and trenches by air blast and air induced ground shock is usually not significant except at ranges less than those shown for severe damage in figure 7–22.

*Table 7–4. Damage Criteria for Field Fortifications*

| Description | Severe |
|---|---|
| Unrevetted trenches and foxholes with or without light cover. | The trench or foxhole is at least 50 percent filled with earth. |

### FIGURES 7-20—7-22

The curves in figure 7–22 are based on results of tests run in a *consolidated dry sand and gravel soil*. Trenches and foxholes in damp soil with stable vegetation or dry silty soil will receive moderate and severe damage at ranges less than those shown in figure 7–22. The curves of figure 7–22 are for average rectangular foxholes with the longitudinal axis perpendicular to the direction of air blast propagation. Damage will be equal or less for other orientations.

*Given:* A 50 KT burst at an altitude of 1,000 feet.

*Find:* To what horizontal distance there is a 50 percent probability of severe damage to an unrevetted foxhole in a dry, consolidated sand and gravel soil.

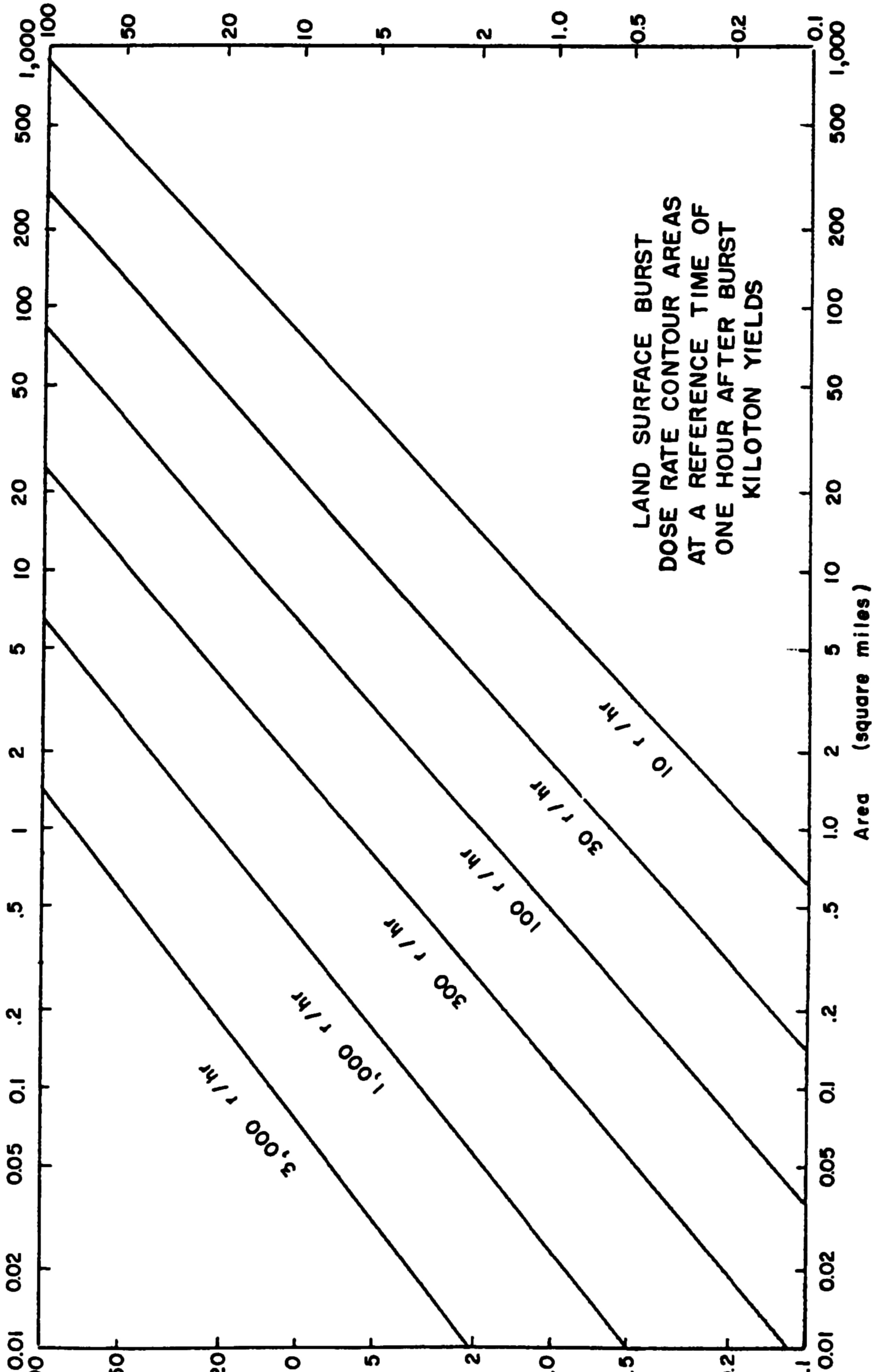
*Solution:* 680 yards.

**Approximately 20 psi peak overpressure**

*Table 7–3. Damage Criteria for Underground Structures*

| Structure | Damage | Damage distance | Remarks |
|---|---|---|---|
| Relatively small, heavy, well designed underground targets. | Severe | $1\frac{1}{4}R_a$ | Collapse. |
| | Light | $2R_a$ | Slight cracking, severance of brittle external connections. |
| Relatively long, flexible targets, such as buried pipelines, tanks, etc. | Severe | $1\frac{1}{2}R_a$ | Deformation and rupture. |
| | Moderate | $2R_a$ | Slight deformation and rupture. |
| | Light | $2\frac{1}{2}$ to $3R_a$ | Failure of connections. (Use higher value for radial orientation of connections.) |

*Note.* $R_a$=Apparent Crater Radius.


LAND SURFACE BURST
DOSE RATE CONTOUR AREAS
AT A REFERENCE TIME OF
ONE HOUR AFTER BURST
KILOTON YIELDS
10 r / hr
30 r / hr
100 r / hr
300 r / hr
1,000 r / hr
3,000 r / hr
Area (square miles)
0.01 0.02 0.05 0.1 .2 .5 1.0 2 5 10 20 50 100 200 500 1,000
Fission Yield = Total Yield (kilotons)
100 50 20 10 5 2 1.0 0.5 0.2 0.1

DNA EM-1
PART I

DEFENSE NUCLEAR AGENCY EFFECTS MANUAL NUMBER 1

# CAPABILITIES OF NUCLEAR WEAPONS

1 JULY 1972

HEADQUARTERS
Defense Nuclear Agency
Washington, D.C. 20305

# FOREWORD

This edition of the *Capabilities of Nuclear Weapons* represents the continuing efforts by the Defense Nuclear Agency to correlate and make available nuclear weapons effects information obtained from nuclear weapons testing, small-scale experiments, laboratory effort and theoretical analysis. This document presents the phenomena and effects of a nuclear detonation and relates weapons effects manifestations in terms of damage to targets of military interest. It provides the source material and references needed for the preparation of operational and employment manuals by the Military Services.

The *Capabilities of Nuclear Weapons* is not intended to be used as an employment or design manual by itself, since more complete descriptions of phenomenological details should be obtained from the noted references. Every effort has been made to include the most current reliable data available on 31 December 1971 in order to assist the Armed Forces in meeting their particular requirements for operational and target analysis purposes.

Comments concerning this manual are invited and should be addressed:

Director
Defense Nuclear Agency
ATTN: STAP
Washington, D. C. 20305

C. H. DUNN
Lt General, USA
Director

**Table 10-1 Estimated Casualty Production in Buildings for Three Degrees of Structural Damage**

| Structural Damage | Percent of Personnel* | | |
|---|---|---|---|
| | Killed Outright | Serious Injury (hospitalization) | Light Injury (no hospitalization) |
| 1-2 story brick homes (high-explosive data from England): | | | |
| Severe damage | 25 | 20 | 10 |
| Moderate damage | <5 | 10 | 5 |
| Light damage | – | <5 | <5 |
| Reinforced-concrete buildings (nuclear data from Japan): | | | |
| Severe damage | 100 | – | – |
| Moderate damage | 10 | 15 | 20 |
| Light damage | <5 | <5 | 15 |

*These percentages do not include the casualties that may result from fires, asphyxiation, and other causes from failure to extricate trapped personnel. The numbers represent the estimated percentages of casualties expected at the maximum range where a specified structural damage occurs. See Chapter 11 for the distances at which these degrees of damage occur for various yields.

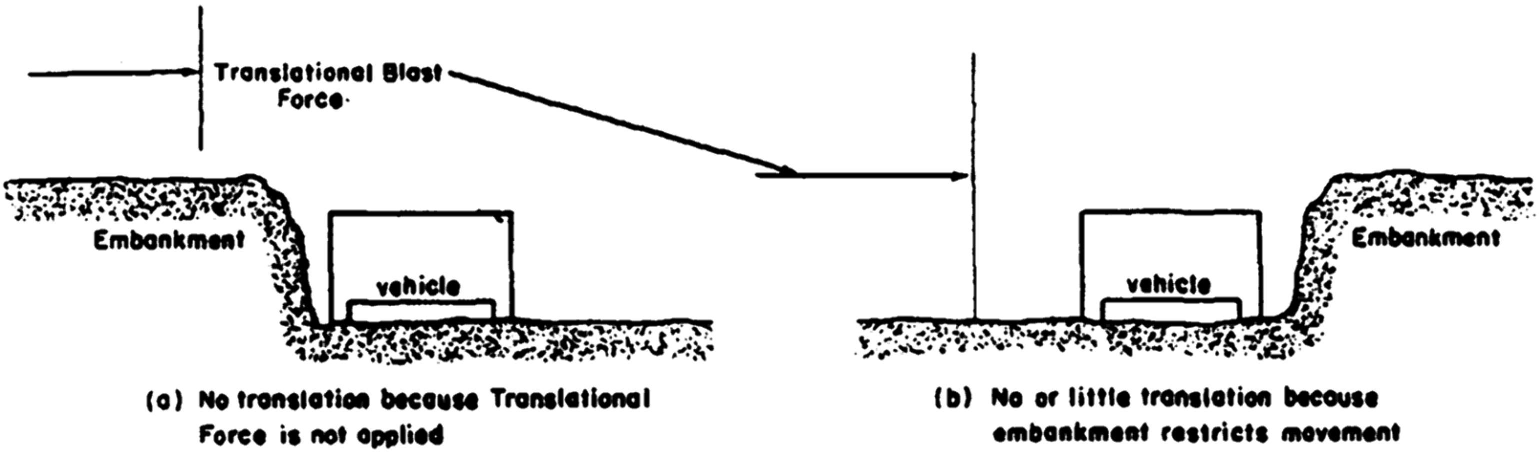



Figure 14-8. The Effect of Shielding

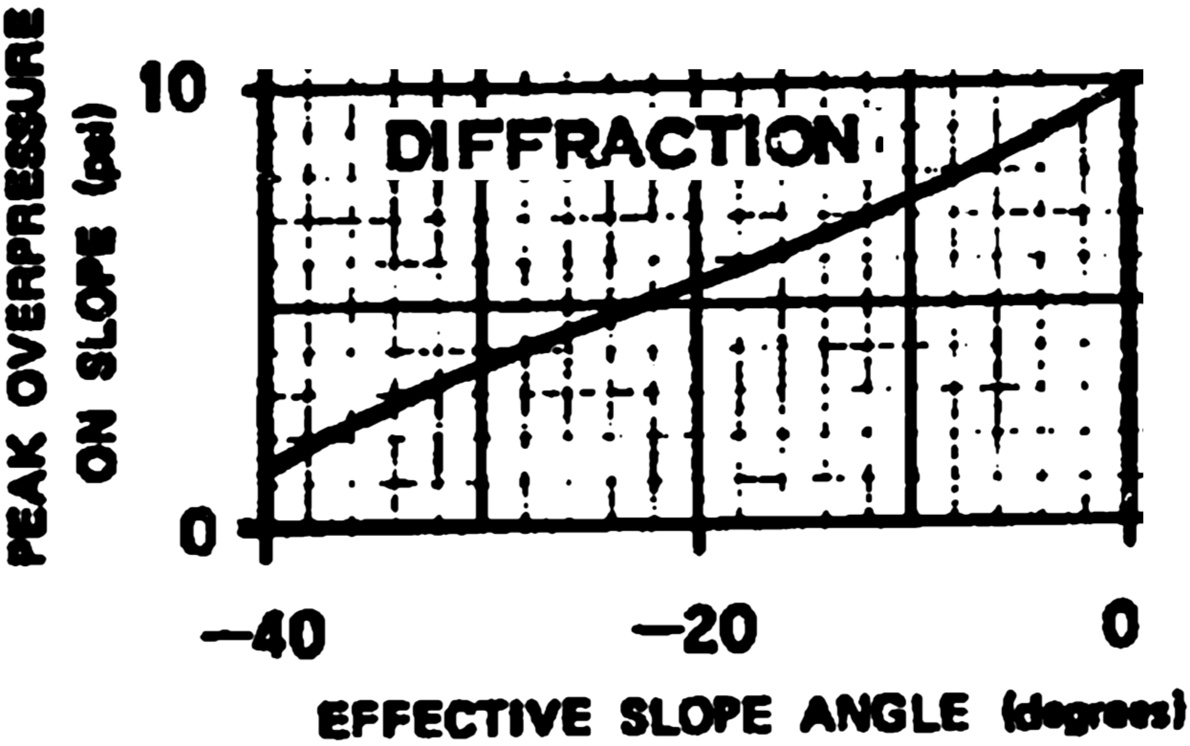



Figure 2-53. Peak Overpressure Produced on a Slope by a 10-psi Incident Mach Stem as a Function of a Slope Angle

If the pulse is of long duration, the ignition threshold rises because the exposed material can dissipate an appreciable fraction of the energy while it is being received. For very long rectangular pulses an irradiance of about 0.5 cal $\cdot$ $cm^{-2} sec^{-1}$ is required to ignite the cellulose. Heat supplied to the material at a slow rate is just sufficient to offset radiative and convective heat losses, while maintaining the cellulose at the ignition temperature of about 300°C.

9-19

Most thick, dense materials that ordinarily are considered inflammable do not ignite to persistent flaming ignition when exposed to transient thermal radiation pulses. Wood, in the form of siding or beams, may flame during the exposure but the flame is extinguished when the exposure ceases.

9-25

TECHNICAL ANALYSIS REPORT - AFSWP NO. 507

# RADIOACTIVE FALL-OUT HAZARDS FROM SURFACE BURSTS OF VERY HIGH YIELD NUCLEAR WEAPONS

by

D. C. Borg
L. D. Gates
T. A. Gibson, Jr.
R. W. Paine, Jr.

MAY 1954

HEADQUARTERS, ARMED FORCES SPECIAL WEAPONS PROJECT
WASHINGTON 13, D. C.

e. Passive defense measures, intelligently applied, can drastically reduce the lethally hazardous areas. A course of action involving the seeking of optimum shelter, followed by evacuation of the contaminated area after a week or ten days, appears to offer the best chance of survival. At the distant downwind areas, as much as 5 to 10 hours after detonation time may be available to take shelter before fall-out commences.

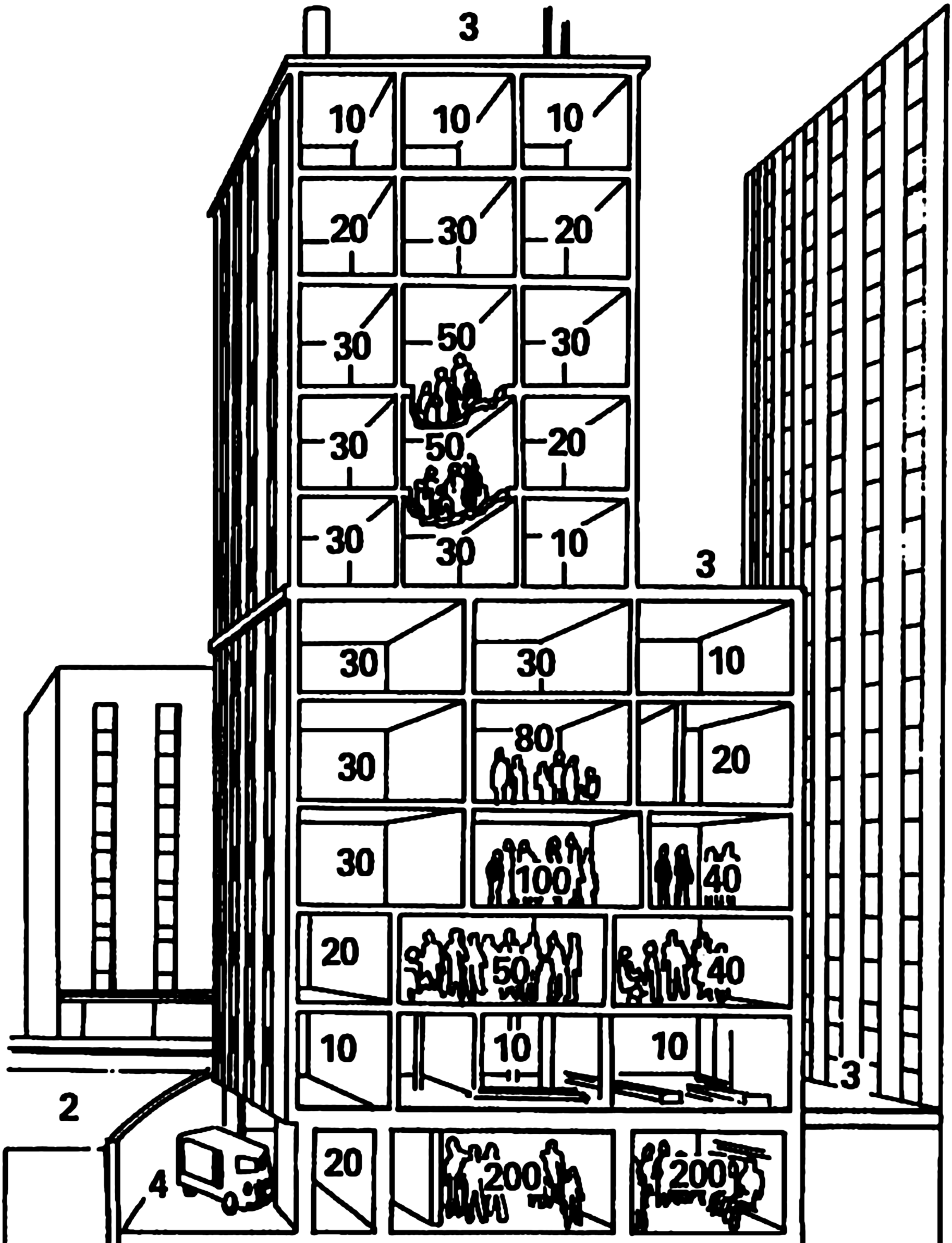
f. Universal use of a simply constructed deep underground shelter, a subway tunnel, or the sub-basement of a large building could eliminate the lethal hazard due to external radiation from fall-out completely, if followed by evacuation from the area when ambient radiation intensities have decayed to levels which will permit this to be done safely.



Table II

Total Isodose Contour: 500r from Fall-out to H+50 Hours

| Yield (MT) | 15 | 1 | 10 | 60 |
|---|---|---|---|---|
| Downwind extent (mi) | 180 | 52 | 152 | 340 |
| Area ($mi^2$) | 5400 | 470 | 3880 | 17,900 |




Radiation protection factors in modern city buildings
DCPA Attack Environment Manual, ch. 6, panel 18

# SANDIA REPORT

SAND2009-3299
Unlimited Release
Printed May 2009

# Analysis of Sheltering and Evacuation Strategies for an Urban Nuclear Detonation Scenario

Larry D. Brandt, Ann S. Yoshimura

## Executive Summary

A nuclear detonation in an urban area can result in large downwind areas contaminated with radioactive fallout deposition. Early efforts by local responders must define the nature and extent of these areas, and advise the affected population on strategies that will minimize their exposure to radiation. These strategies will involve some combination of sheltering and evacuation actions. Options for shelter-evacuate plans have been analyzed for a 10 kt scenario in Los Angeles.

---

Results from the analyses documented in this report point to the following conclusions:

- When high quality shelter (protection factor ~10 or greater) is available, shelter-in-place for at least 24 hours is generally preferred over evacuation.
- Early shelter-in-place followed by informed evacuation (where the best evacuation route is employed) can dramatically reduce harmful radiation exposure in cases where high quality shelter is not immediately available.
- Evacuation is of life-saving benefit primarily in those hazardous fallout regions where shelter quality is low and external fallout dose rates are high. These conditions may apply to only small regions within the affected urban region.
- External transit from a low quality shelter to a much higher quality shelter can significantly reduce radiation dose received if the move is done soon after the detonation and if the transit times are short.

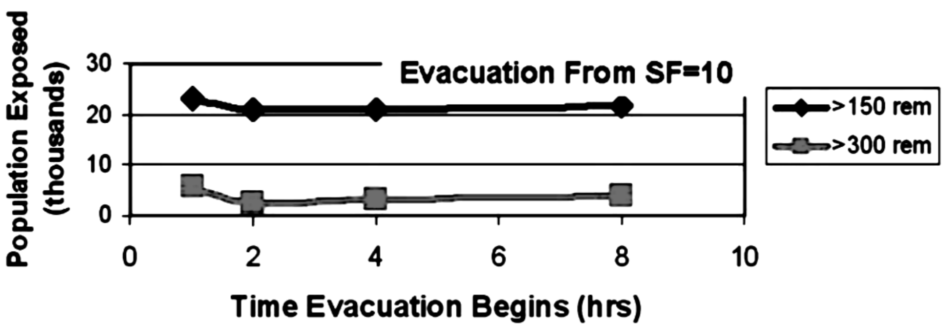
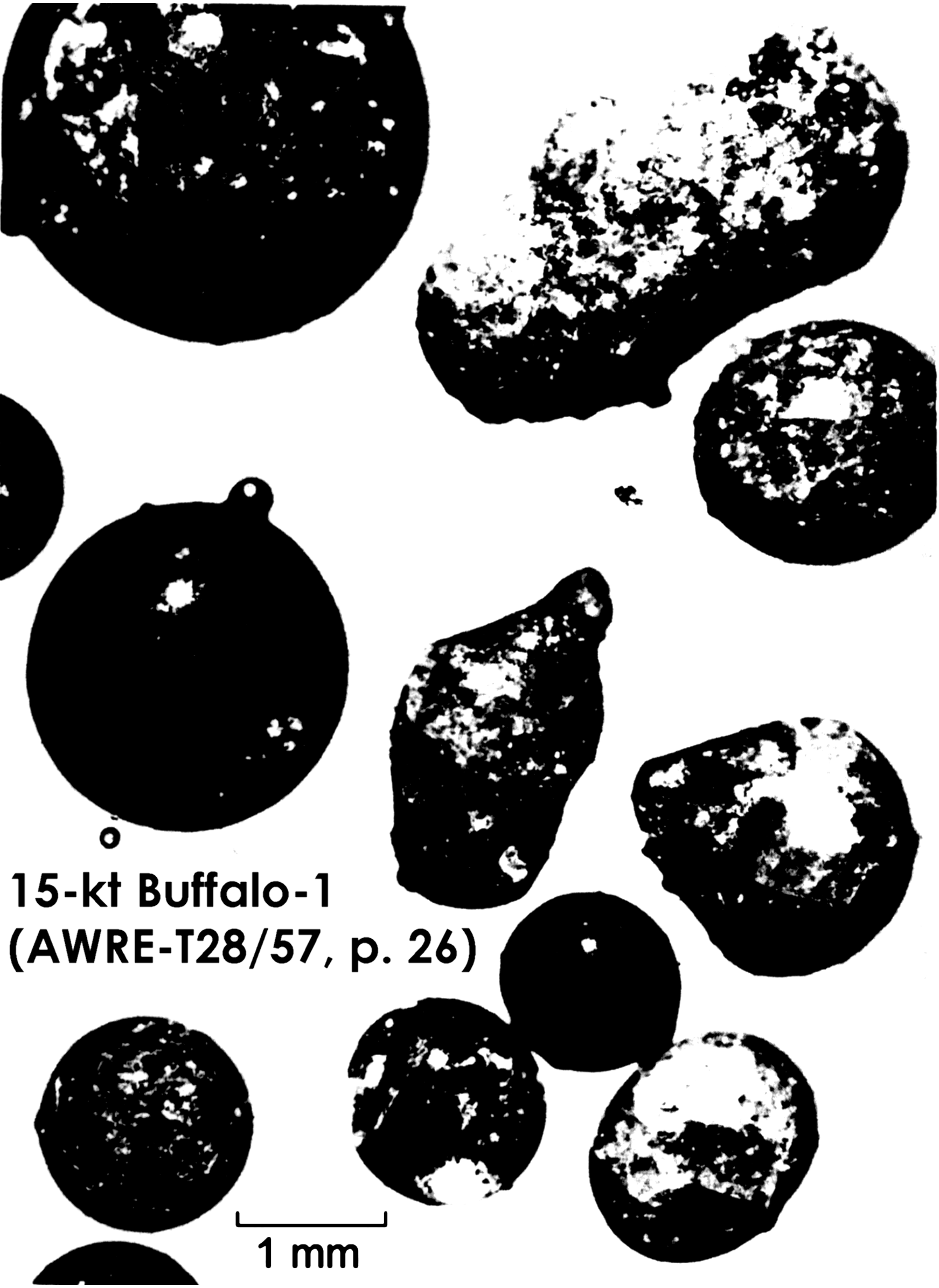
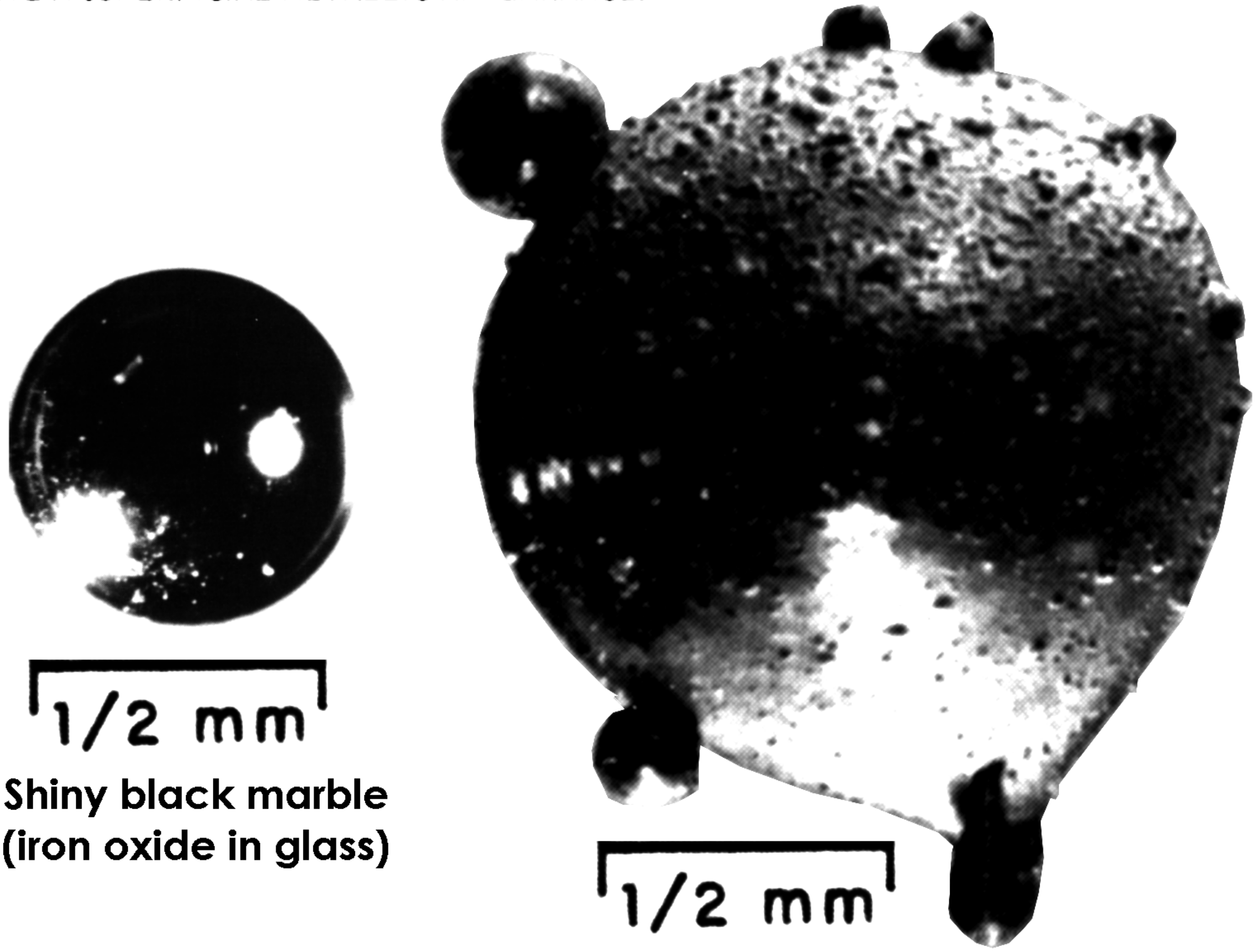



**Figure 12.** Departure time sensitivities for informed evacuations from shelters with SF=4

Sandia National Laboratories

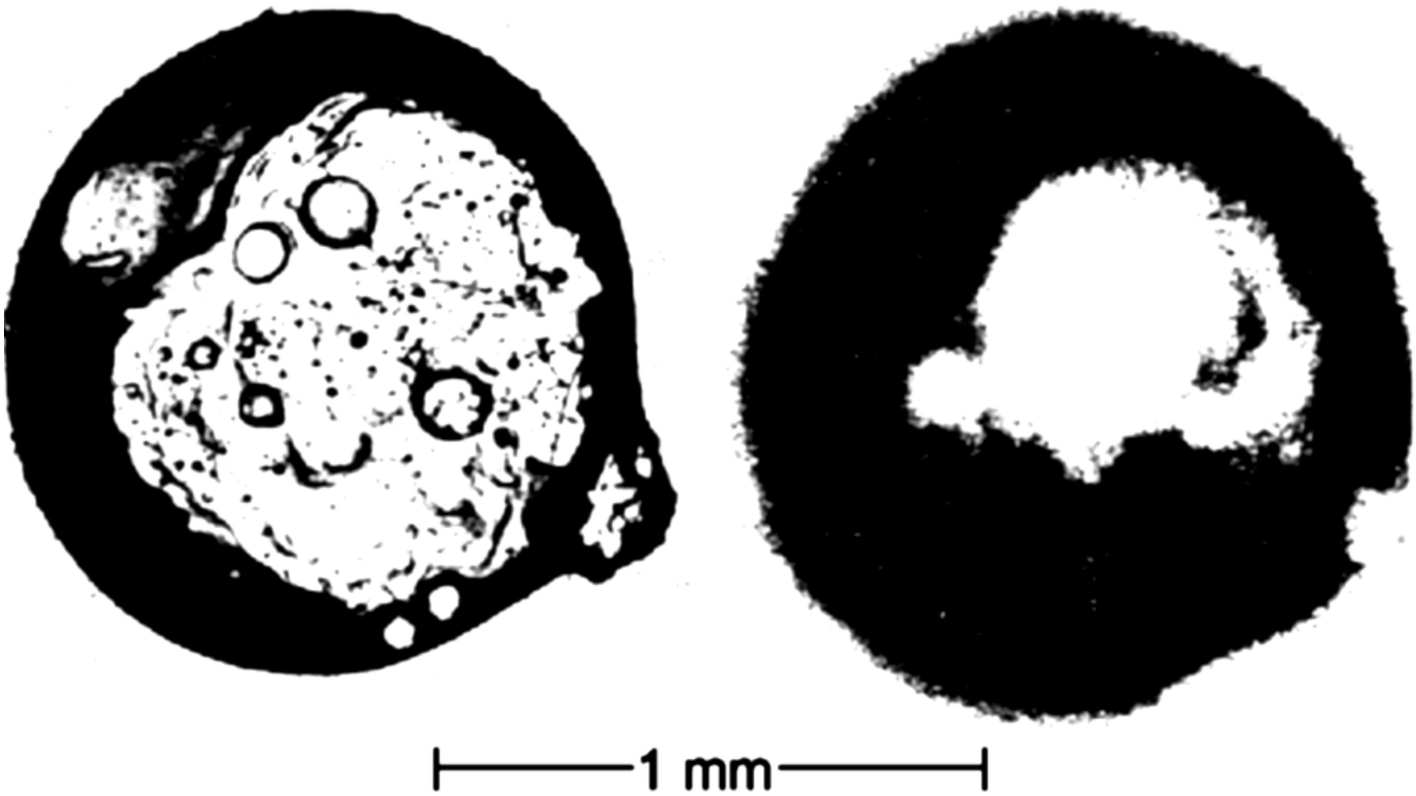

15-kt Buffalo-1
(AWRE-T28/57, p. 26)
1 mm

TWO FALLOUT PARTICLES FROM A TOWER SHOT AT THE NEVADA TEST SITE. THE PARTICLE ON THE LEFT IS A PERFECT SPHERE WITH A HIGHLY GLOSSY SURFACE; THE ONE ON THE RIGHT HAS MANY PARTIALLY-ASSIMILATED SMALLER SPHERES ATTACHED TO ITS SURFACE. BOTH PARTICLES ARE BLACK AND MAGNETIC AND HAVE A SUPERFICIAL METALLIC APPEARANCE.




**Shiny black marble (iron oxide in glass)**

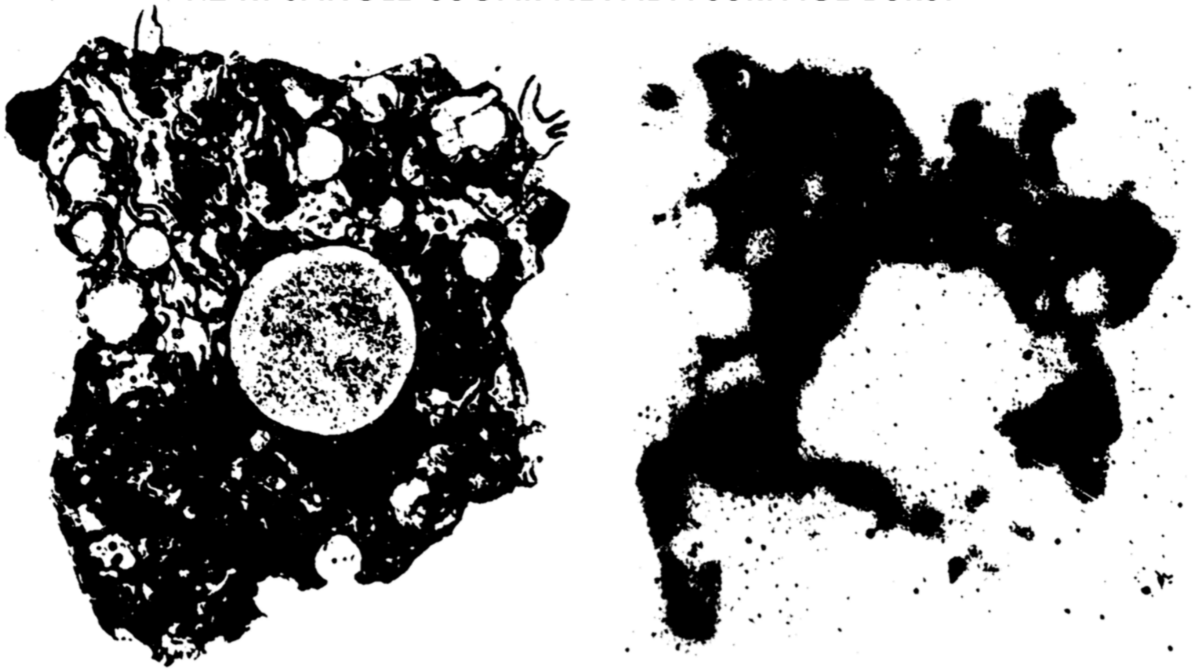
THIN SECTION AND RADIOGRAPH OF A FALLOUT PARTICLE FROM A MODERATE-YIELD TOWER SHOT AT THE NEVADA TEST SITE. THIS PARTICLE IS COMPOSED OF A TRANSPARENT GLASS CORE WITH A DARKLY COLORED IRON OXIDE GLASS OUTER ZONE. MOST OF THE RADIOACTIVITY IS CONCENTRATED IN THE OUTER ZONE




C.E. Adams. The Nature of Individual Radioactive Particles. IV. Fallout Particles From A.B.D. of Operation UPSHOT-KNOTHOLE. U.S. Naval Radiological Defense Laboratory Report, USNRDL-440, February 24, 1954

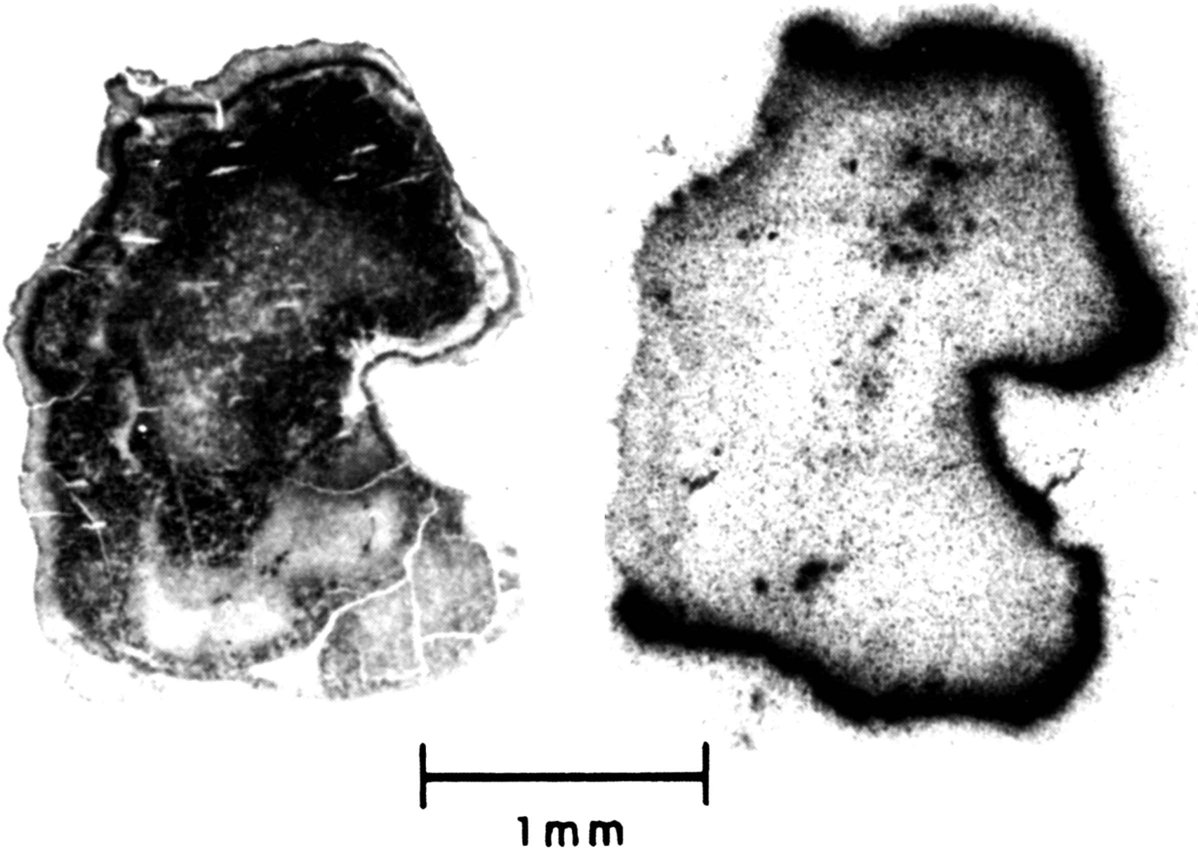
THIN SECTION AND RADIOGRAPH OF A FALLOUT PARTICLE FROM A SMALL-YIELD SURFACE SHOT AT THE NEVADA TEST SITE. THE PARTICLE IS A TRANSPARENT YELLOW-BROWN GLASS WITH MANY INCLUSIONS OF GAS BUBBLES AND UNMELTED MINERAL GRAINS. THE RADIOACTIVITY IS DISTRIBUTED IRREGULARLY THROUGHOUT THE GLASS PHASE OF THE PARTICLE

## 1.2 KT JANGLE-SUGAR NEVADA SURFACE BURST

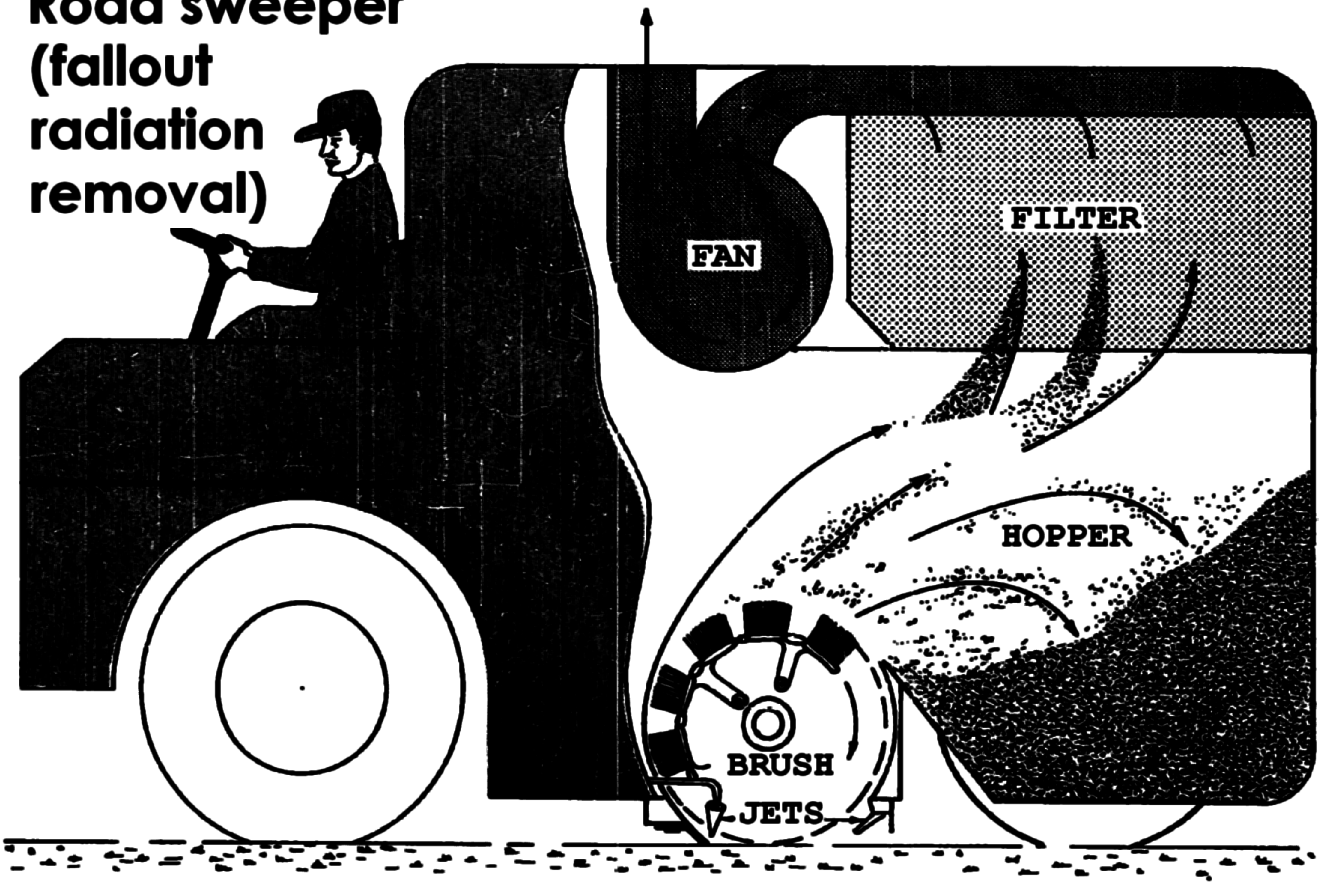


C.E. Adams, et al. The Nature of Individual Radioactive Particles. I. Surface and Underground A.B.D. Particles From Operation JANGLE. U.S. Naval Radiological Defense Laboratory Report, USNRDL-374, November 28, 1952

THIN SECTION AND RADIOGRAPH OF AN ANGULAR FALLOUT PARTICLE FROM A LARGE-YIELD SURFACE SHOT AT THE ENIWETOK PROVING GROUNDS. THIS PARTICLE IS COMPOSED ALMOST ENTIRELY OF CALCIUM HYDROXIDE WITH A THIN OUTER LAYER OF CALCIUM CARBONATE. THE RADIOACTIVITY HAS COLLECTED ON THE SURFACE AND HAS DIFFUSED A SHORT DISTANCE INTO THE PARTICLE



## Road sweeper (fallout radiation removal)



USNRDL-TR-1049
28 July 1966

AD 641480

# REMOVAL OF SIMULATED FALLOUT FROM ASPHALT STREETS BY FIREHOSING TECHNIQUES


by

L.L.Wiltshire
W.L.Owen



In general, removal effectiveness improves with increased particle size range and increased mass loading. For the expenditure of an effort of 4 nozzle-minutes (12 man-minutes) per $10^3$ ft$^2$, results ranged as follows:

| Particle Size Range (μ) | Nominal Mass Loading (g/ft$^2$) | Removal Effectiveness (Residual Fraction) |
|---|---|---|
| 44 - 88 | 4.0 | 0.16 |
| | 24.0 | 0.07 |
| 350 - 700 | 4.0 | 0.005 |
| | 24.0 | 0.003 |



U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY

SAN FRANCISCO · CALIFORNIA 94135


TRINITY GROUND ZERO:
8000 R/hr at 1 hour
1.4 R/hr at
57 days
11 Sept. 1945

# LAND SURFACE BURST

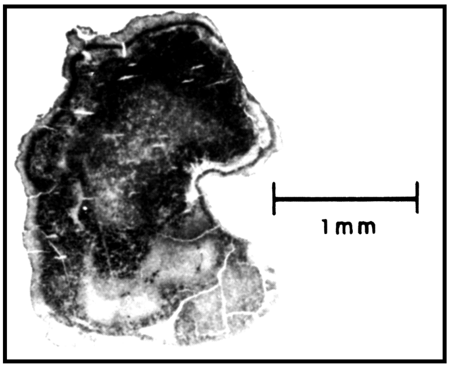
A FALLOUT FORECASTING TECHNIQUE WITH RESULTS OBTAINED AT THE ENIWETOK PROVING GROUND

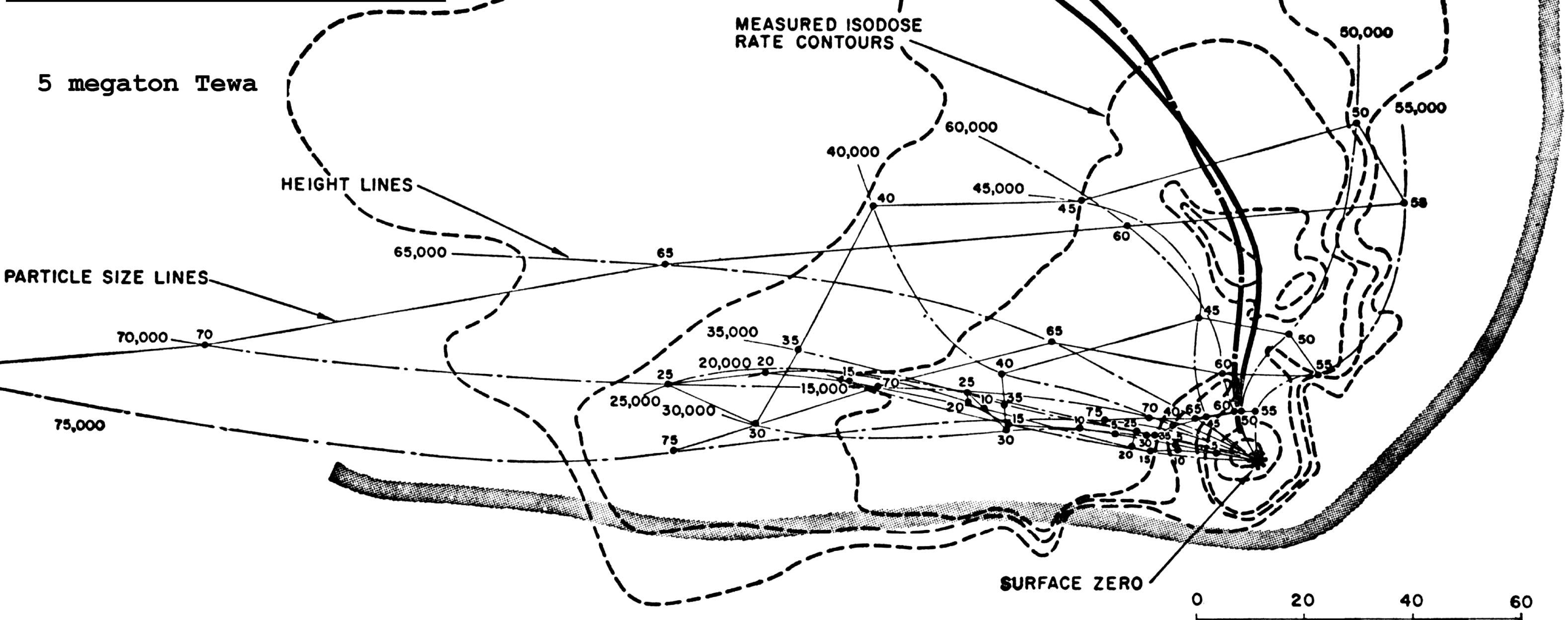
E. A. Schuert, USNRDL TR-139, United States Naval Radiological Defense Laboratory, San Francisco, Calif.

2.36 g/cu cm irregular in shape

*Falling speeds* (feet/hour)

| Altitude | 75 μ | 100 μ | 200 μ | 350 μ |
|---|---|---|---|---|
| 0 | 3,060 | 5,040 | 11,700 | 21,600 |
| 20 | 3,360 | 5,980 | 14,400 | 27,100 |
| 40 | 3,870 | 6,910 | 18,600 | 35,300 |
| 60 | 4,200 | 7,700 | 24,400 | 47,200 |
| 80 | 3,910 | 6,960 | 27,800 | 61,900 |

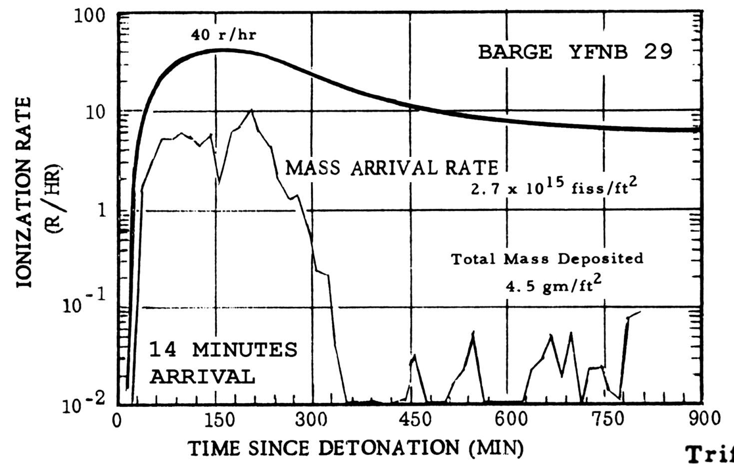


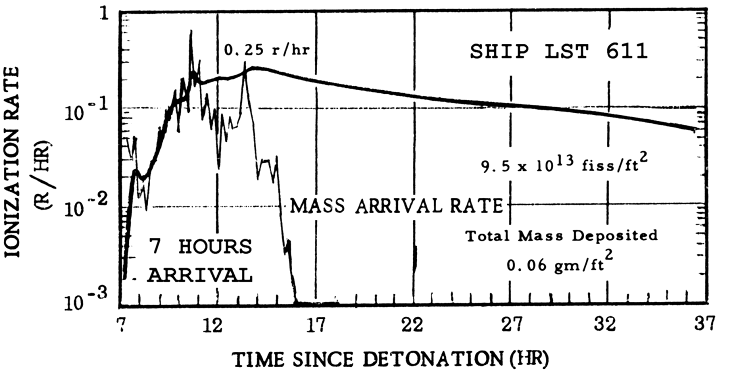

*Comparison of fallout forecast with test results*

**HEIGHT LINE = DESTINATIONS FOR A FIXED HEIGHT OF ORIGIN FOR VARIOUS SIZES**
**SIZE LINE = DESTINATIONS FOR A FIXED PARTICLE SIZE FROM VARIOUS HEIGHTS**
**HOT LINE = HEIGHT LINE FROM BASE OF MUSHROOM DISC (MAXIMUM FALLOUT)**

5 MT TEWA (87% FISSION), 7.84 STAT. MILES WSW




5 MT TEWA (87% FISSION), 59.3 STAT. MILES NW




Triffet, T. and LaRiviere, P. D.; Characterization of Fallout

# CLEAN BOMB: 3.53 MT (15% FISSION) ZUNI

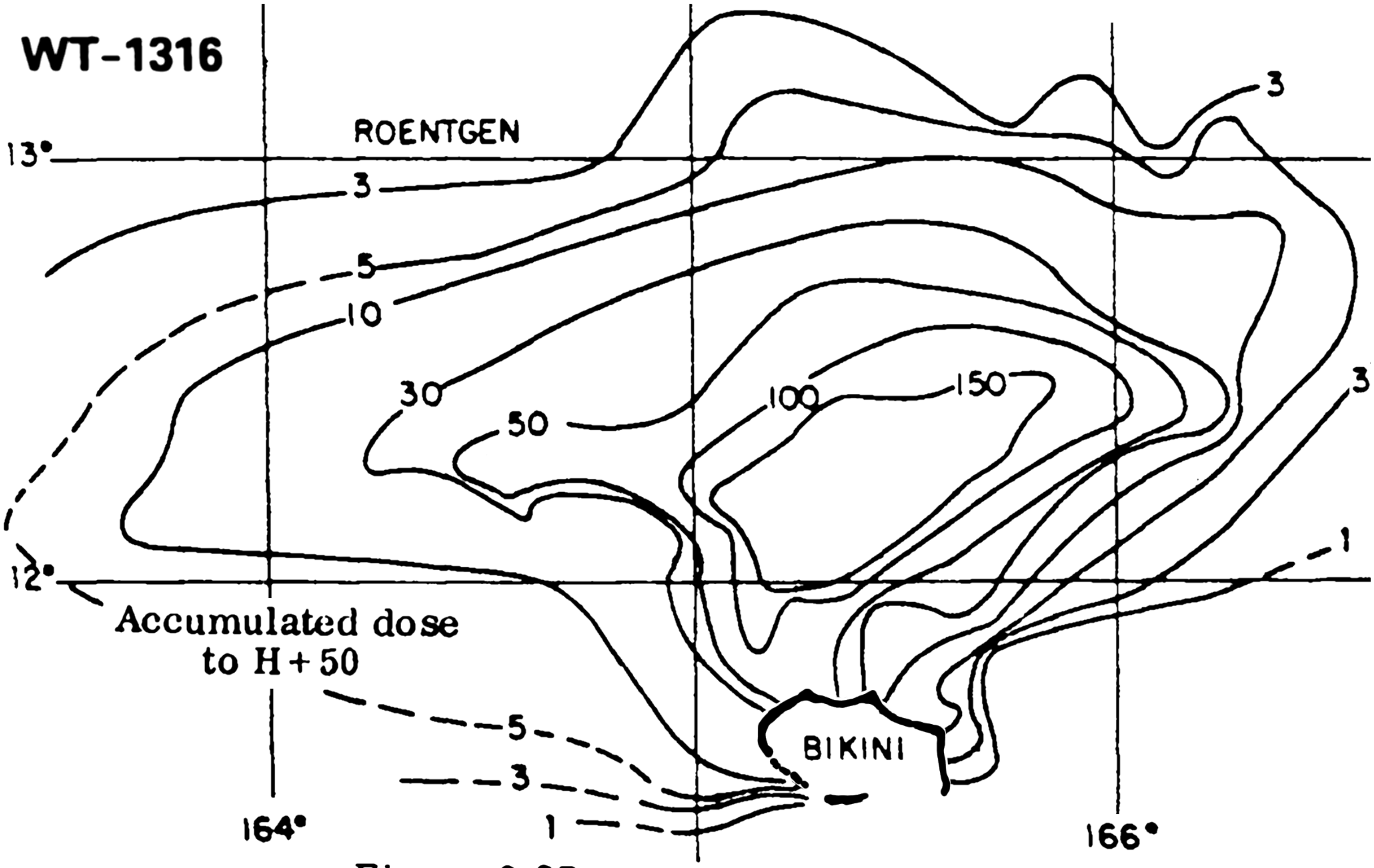



Figure 2.37

# DIRTY BOMB: 5.01 MT (87% FISSION) TEWA

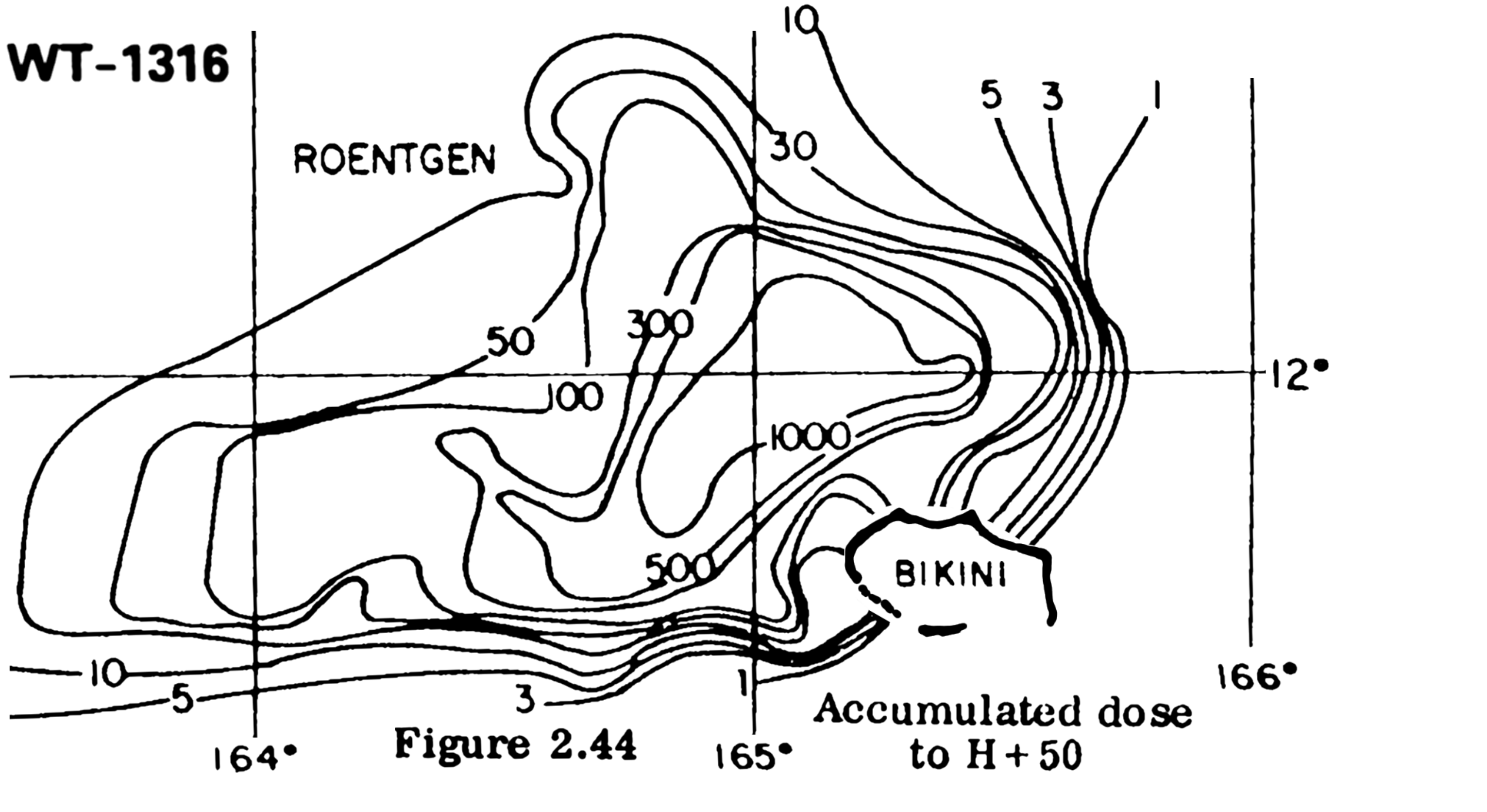



Figure 2.44

## TABLE 2.11

| | Navajo | Tewa |
|---|---|---|
| Total Yield, Mt | 4.50 | 5.01 |
| Fission proportion | 5% | 87% |

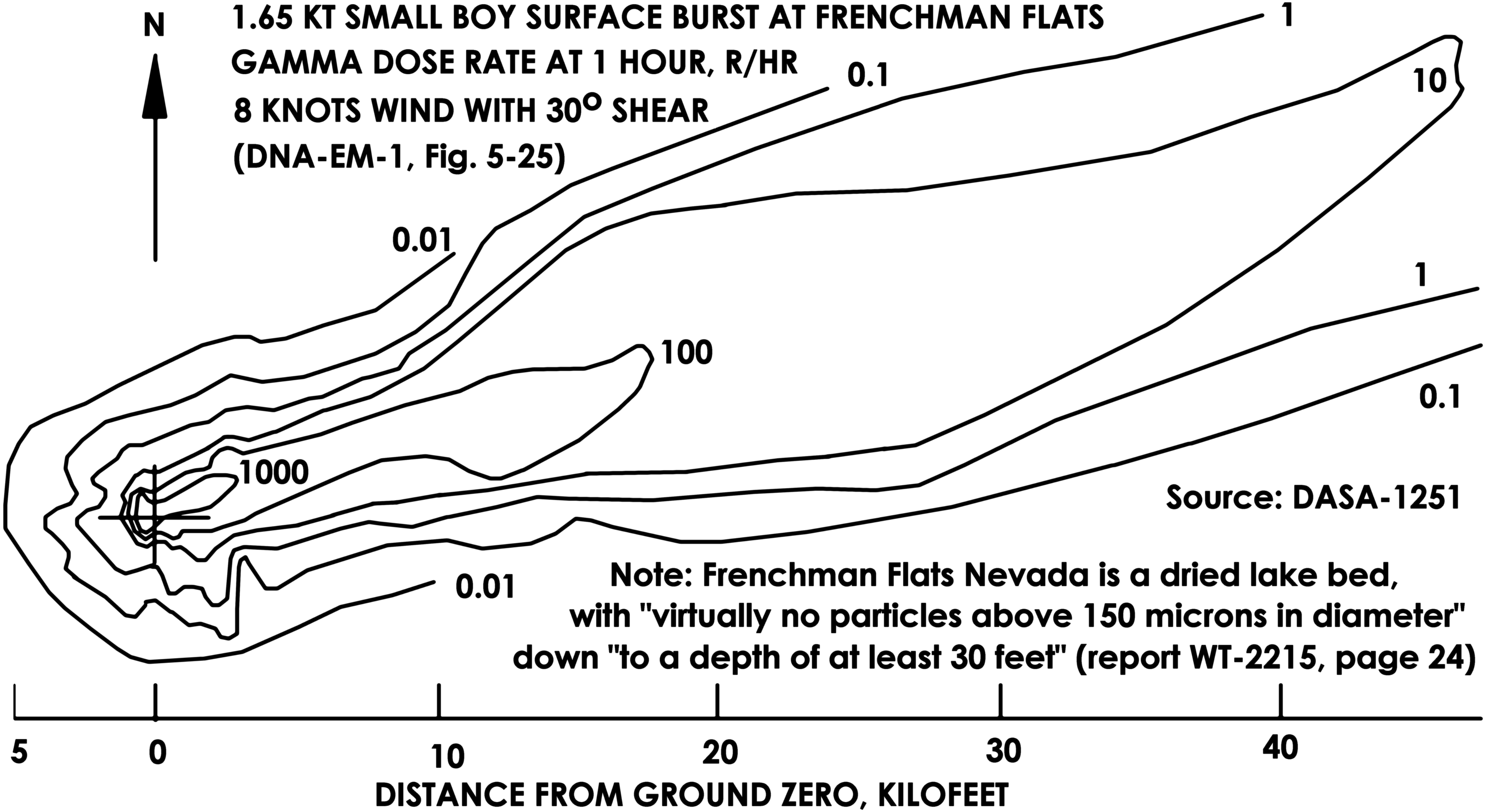
| H + 1 Hour Dose Rate (r/hr) | Area ($mi^2$) Within Contour | |
|---|---|---|
| 1,000 | 25 | 450 |
| 500 | 55 | 1,050 |
| 300 | 80 | 1,550 |
| 100 | 310 | 3,500 |

| Two-day Dose, R | Area ($mi^2$) Within Contour | |
|---|---|---|
| 1,000 | 20 | 520 |
| 500 | 30 | 1,050 |
| 300 | 45 | 1,500 |
| 100 | 350 | 3,000 |

AD-A995490
POR-2266 (WT-2266)
TABLE 4.1

## AREAS ENCLOSED BY DOSE RATE CONTOURS

| | 0.018 kt | 0.022 kt | 0.5 kt | 1.65 kt |
|---|---|---|---|---|
| Contour Dose Rate, I | Area Within Contour | | | |
| | Little Feller I | Little Feller II | Johnie Boy | Small Boy |
| r/hr | $mi^2$ | $mi^2$ | $mi^2$ | $mi^2$ |
| 0.5 | 0.33 | 0.827 | - | 109.83 |
| 1.0 | 0.208 | 0.469 | 33.097 | 61.63 |
| 5.0 | - | 0.070 | - | - |
| 10.0 | 0.032 | 0.045 | 3.924 | 9.057 |
| 20.0 | - | 0.019 | - | - |
| 50.0 | - | - | 0.536 | 2.954 |
| 100.0 | 0.00478 | 0.005 | 0.214 | 1.200 |
| 200.0 | - | - | - | 0.285 |
| 1,000.0 | - | - | 0.0917 | 0.092 |
| 2,000.0 | - | - | - | 0.01665 |
| 10,000.0 | - | - | 0.0161 | - |
| 17,000.0 | - | - | 0.00537 | - |

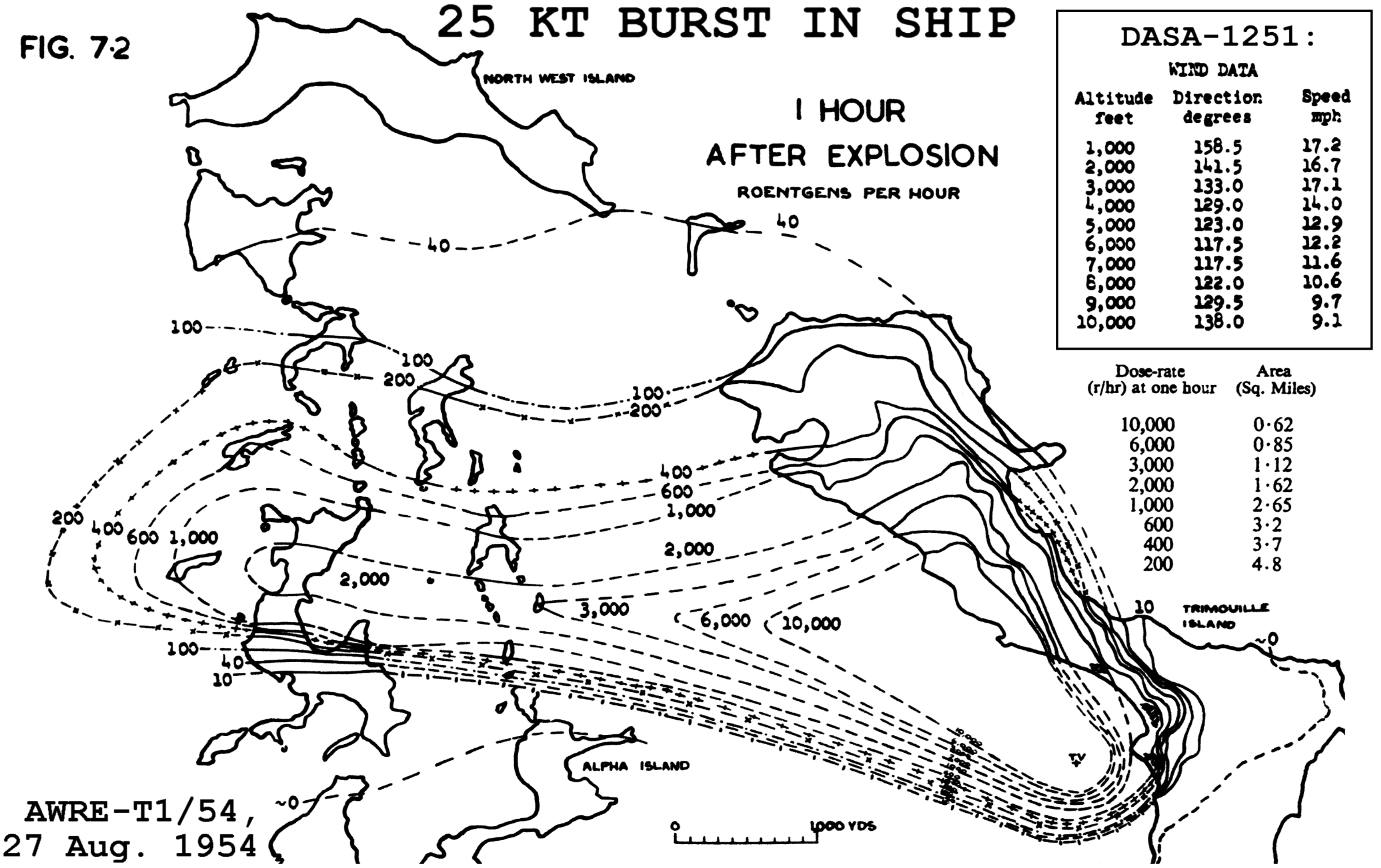


N
1.65 KT SMALL BOY SURFACE BURST AT FRENCHMAN FLATS
GAMMA DOSE RATE AT 1 HOUR, R/HR
8 KNOTS WIND WITH 30$^{\circ}$ SHEAR
(DNA-EM-1, Fig. 5-25)
1
0.1
10
0.01
1
100
0.1
1000
0.01
Source: DASA-1251
Note: Frenchman Flats Nevada is a dried lake bed,
with "virtually no particles above 150 microns in diameter"
down "to a depth of at least 30 feet" (report WT-2215, page 24)
5
0
10
20
30
40
DISTANCE FROM GROUND ZERO, KILOFEET

# OPERATION HURRICANE—THE DOSE-RATE CONTOURS OF THE RESIDUAL RADIOACTIVE CONTAMINATION

## 25 KT BURST IN SHIP

FIG. 7·2



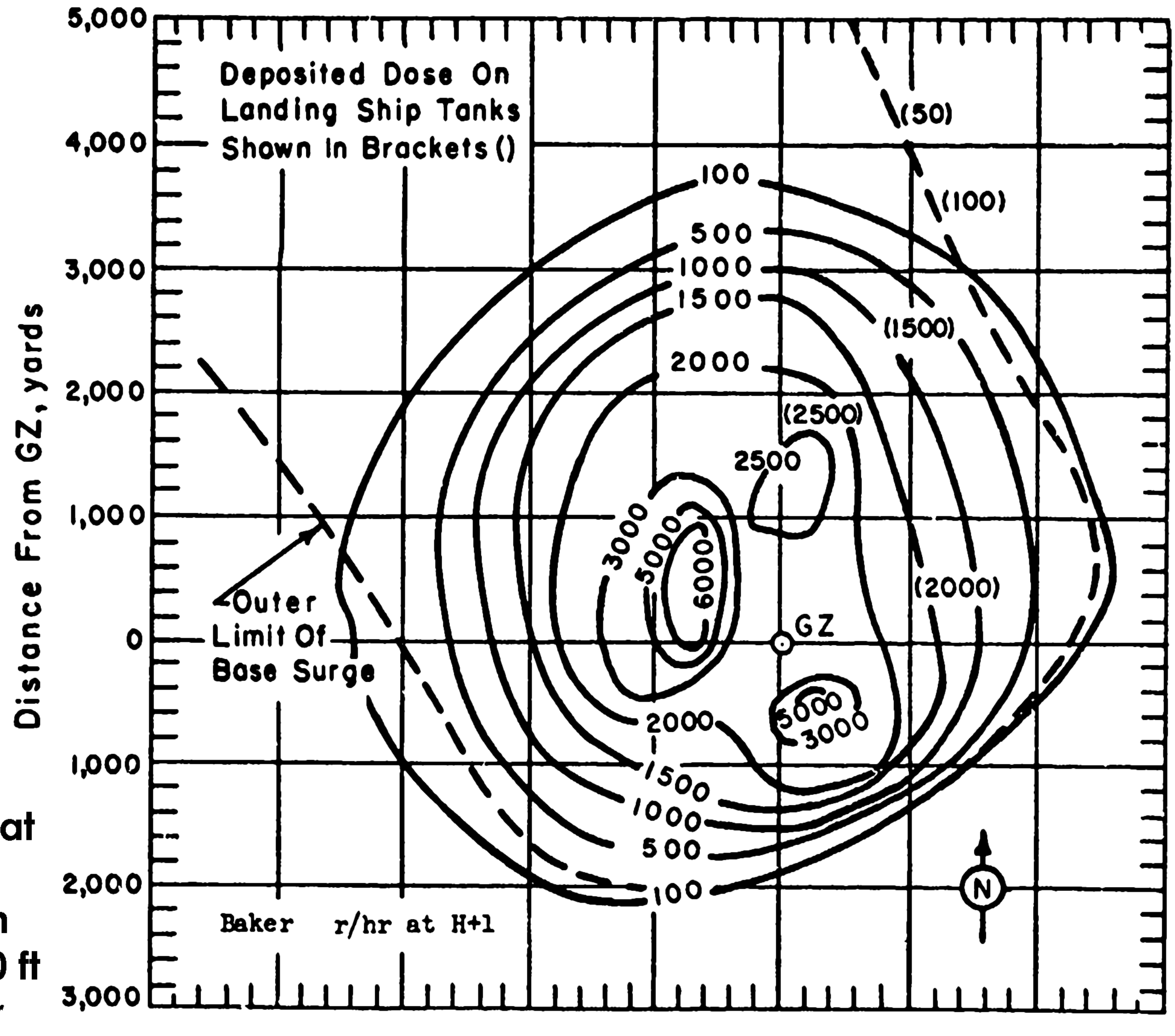

DASA-1251:

WIND DATA

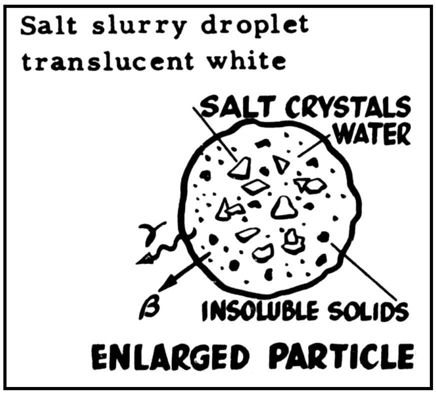
| Altitude feet | Direction degrees | Speed mph |
|---|---|---|
| 1,000 | 158.5 | 17.2 |
| 2,000 | 141.5 | 16.7 |
| 3,000 | 133.0 | 17.1 |
| 4,000 | 129.0 | 14.0 |
| 5,000 | 123.0 | 12.9 |
| 6,000 | 117.5 | 12.2 |
| 7,000 | 117.5 | 11.6 |
| 8,000 | 122.0 | 10.6 |
| 9,000 | 129.5 | 9.7 |
| 10,000 | 138.0 | 9.1 |

| Dose-rate (r/hr) at one hour | Area (Sq. Miles) |
|---|---|
| 10,000 | 0·62 |
| 6,000 | 0·85 |
| 3,000 | 1·12 |
| 2,000 | 1·62 |
| 1,000 | 2·65 |
| 600 | 3·2 |
| 400 | 3·7 |
| 200 | 4·8 |

AWRE-T1/54, 27 Aug. 1954




23 kt at 90 ft depth in 180 ft water




## WATER SURFACE BURST

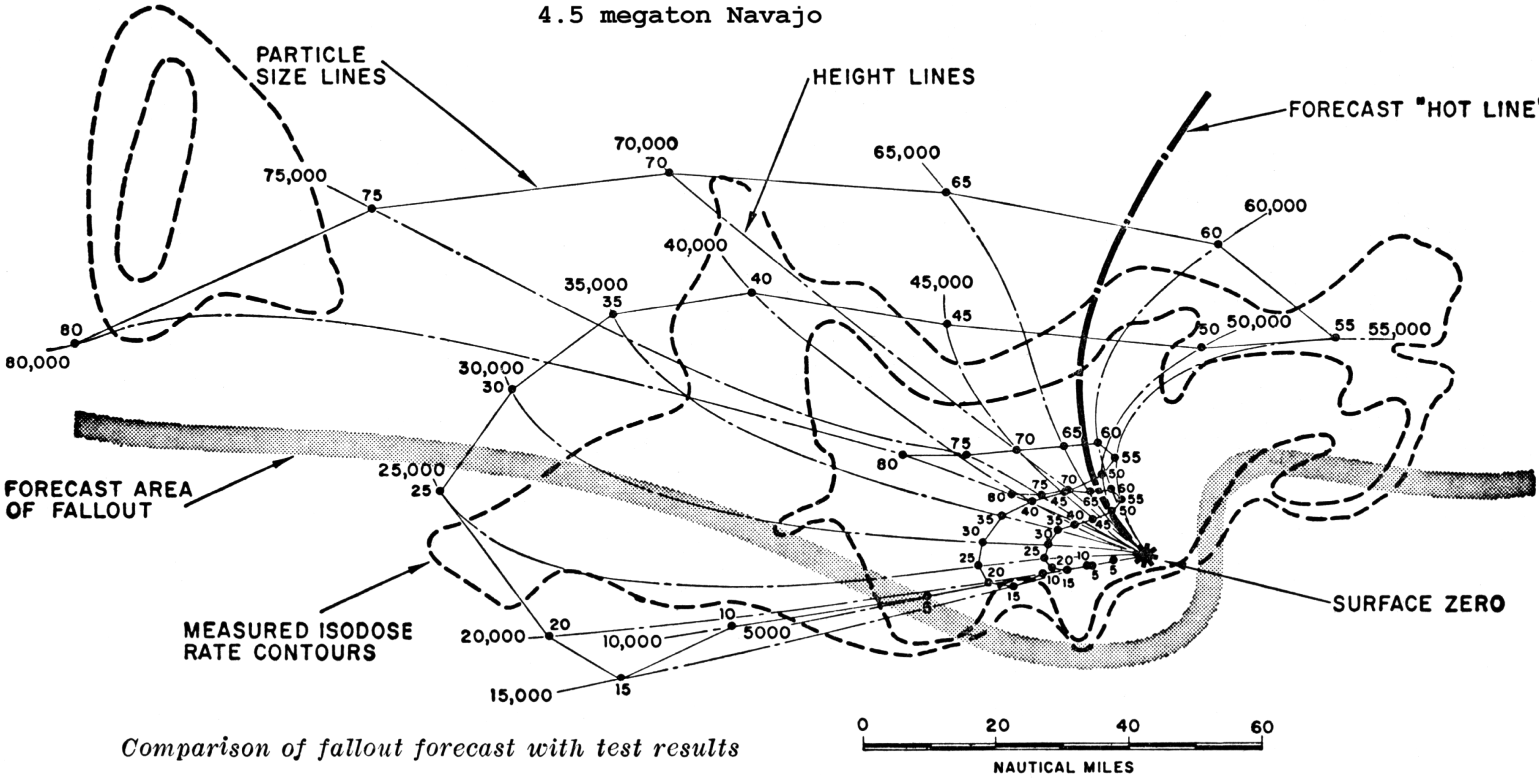
A Fallout Forecasting Technique With Results Obtained at the Eniwetok Proving Ground

E. A. Schuert, USNRDL TR–139, United States Naval Radiological Defense Laboratory, San Francisco, Calif.

*Time variation of the winds aloft*

In most of the observations made at the Eniwetok Proving Ground, the winds aloft were not in a steady state. Significant changes in the winds aloft were observed in as short a period as 3 hours. This variability was probably due to the fact that proper firing conditions which required winds that would deposit the fallout north of the proving ground, occurred only during an unstable synoptic situation of rather short duration.

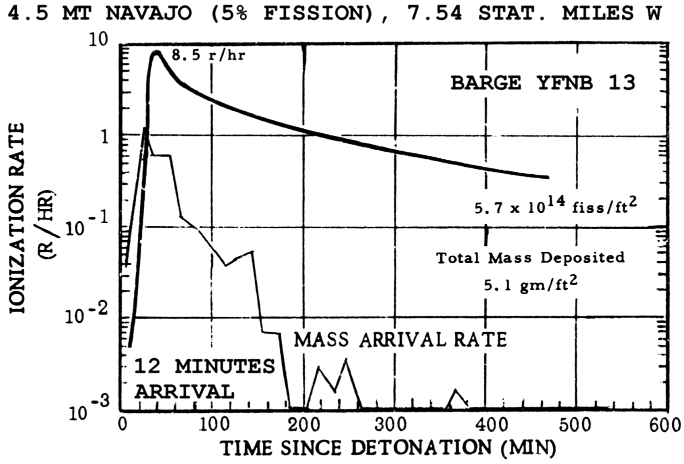
4.5 megaton Navajo



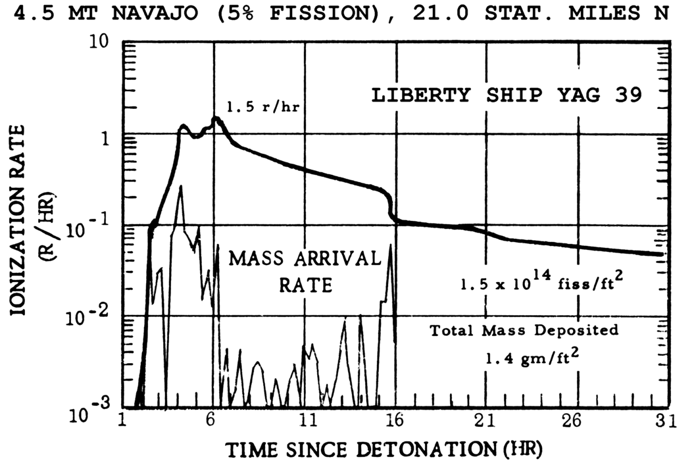

*Comparison of fallout forecast with test results*

**HEIGHT LINE = DESTINATIONS FOR A FIXED HEIGHT OF ORIGIN FOR VARIOUS SIZES**
**SIZE LINE = DESTINATIONS FOR A FIXED PARTICLE SIZE FROM VARIOUS HEIGHTS**
**HOT LINE = HEIGHT LINE FROM BASE OF MUSHROOM DISC (MAXIMUM FALLOUT)**

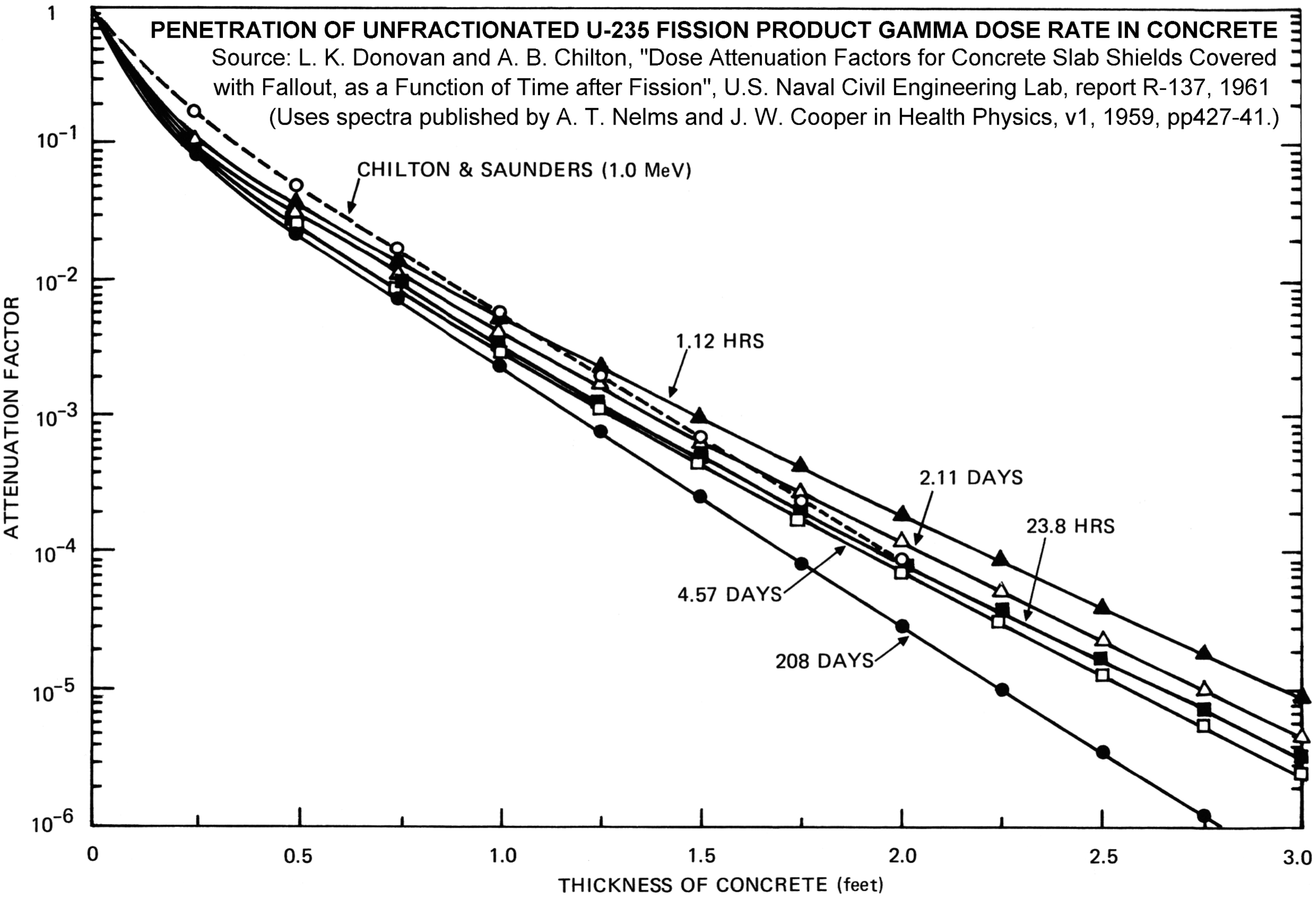
4.5 MT NAVAJO (5% FISSION), 7.54 STAT. MILES W




4.5 MT NAVAJO (5% FISSION), 21.0 STAT. MILES N




Triffet, T. and LaRiviere, P.D.; Characterization of Fallout, Project 2.63


PENETRATION OF UNFRACTIONATED U-235 FISSION PRODUCT GAMMA DOSE RATE IN CONCRETE
Source: L. K. Donovan and A. B. Chilton, "Dose Attenuation Factors for Concrete Slab Shields Covered with Fallout, as a Function of Time after Fission", U.S. Naval Civil Engineering Lab, report R-137, 1961
(Uses spectra published by A. T. Nelms and J. W. Cooper in Health Physics, v1, 1959, pp427-41.)
CHILTON & SAUNDERS (1.0 MeV)
1.12 HRS
2.11 DAYS
23.8 HRS
4.57 DAYS
208 DAYS
ATTENUATION FACTOR
1
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-6}$
0
0.5
1.0
1.5
2.0
2.5
3.0
THICKNESS OF CONCRETE (feet)

HOME OFFICE
SCOTTISH HOME DEPARTMENT

MANUAL OF CIVIL DEFENCE

Volume I

PAMPHLET No. 1

# NUCLEAR WEAPONS

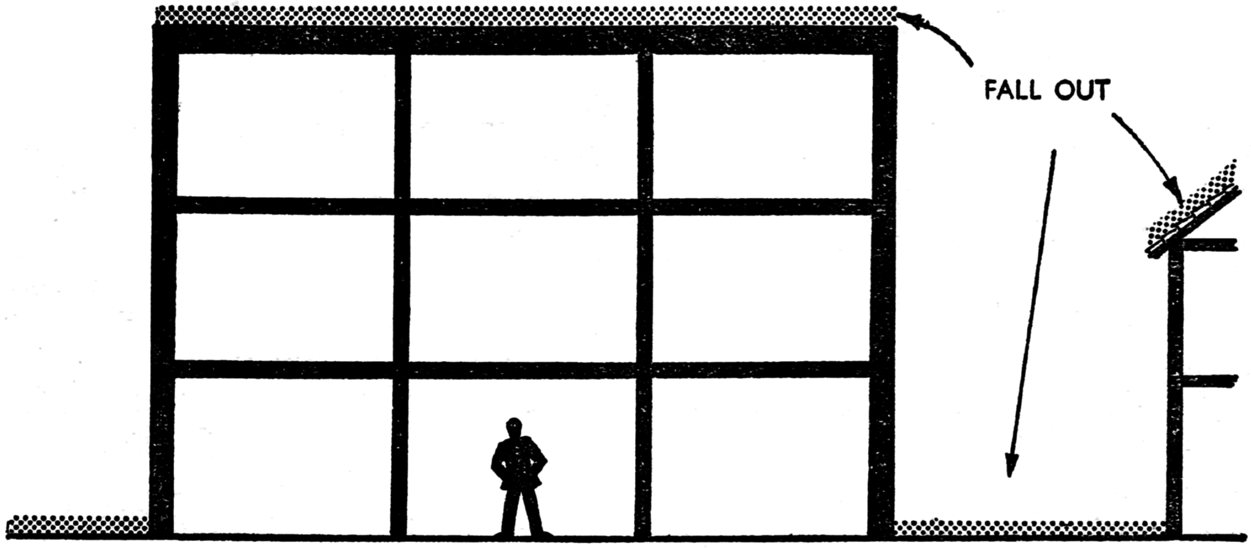
*LONDON*
HER MAJESTY'S STATIONERY OFFICE
1956

## Practical protection

**88** Large buildings with a number of storeys, especially if they are of heavy construction, provide much better protection than small single-storey structures (see Figure 4). Houses in terraces likewise provide much better protection than isolated houses because of the shielding effect of neighbouring houses.

GOOD PROTECTION

Solidly constructed multi-storeyed building with occupants well removed from fall-out on ground and roof. The thickness of floors and roof overhead, and the shielding effect of other buildings, all help to cut down radiation




BAD PROTECTION

Isolated wooden bungalow

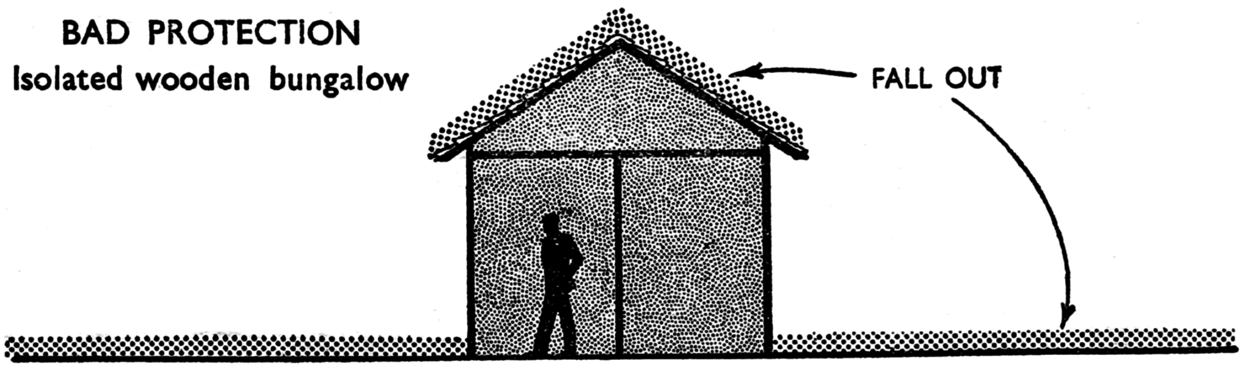



FIGURE 4

Examples of good and bad protection afforded by buildings against fall-out.

**89** It is estimated that the protection factor (the factor by which the outside dose has to be divided to get the inside dose) of a ground floor room in a two-storey house ranges from 10 to about 50, depending on wall thickness and the shielding afforded by neighbouring buildings. The corresponding figures for bungalows are about 10–20, and for three-storey houses about 15–100. An average two-storey brick house in a built-up area gives a factor of 40, but basements, where the radiation from outside the house is attenuated by a very great thickness of earth, have protection factors ranging up to 200–300. A slit trench with even a light cover of boards or corrugated iron without earth overhead gives a factor of 7, and if 1 ft. of earth cover is added the

factor rises to 100. If the trench can be covered with 2 or 3 feet of earth then a factor of more than 200–300 can be obtained (see Figure 5).

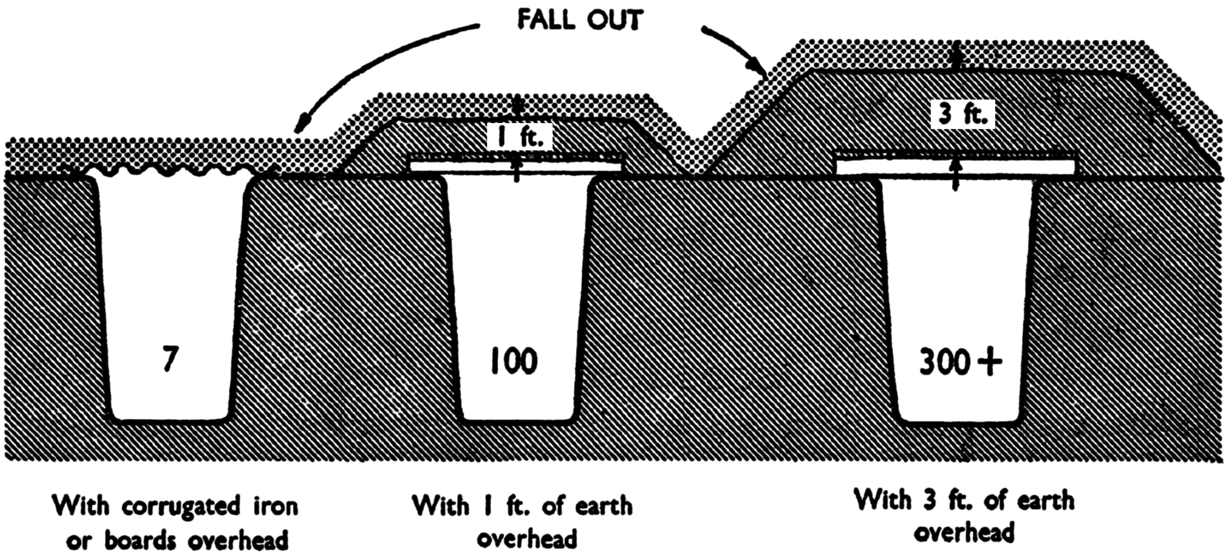



FIGURE 5
Protection factors in slit trenches (the factor by which the outside dose is divided to get the inside dose).

### Choosing a refuge room

90 In choosing a refuge room in a house one would select a room with a minimum of outside walls and make every effort to improve the protection of such outside walls as there were. In particular the windows would have to be blocked up, e.g. with sandbags. Where possible, boxes of earth could be placed round an outside wall to provide additional protection, and heavy furniture (pianos, bookcases etc.) along the inside of the wall would also help. A cellar would be ideal. Where the ground floor of the house consists of boards and timber joists carried on sleeper walls it may be possible to combine the high protection of the slit trench with some of the comforts of the refuge room by constructing a trench under the floor.
Once a trap door had been cut in the floor boards and joists and the trench had been dug, there would be no further interference with the peace-time use of the room.

### Estimated under-cover doses in the fall-out area

91 Taking an average protective factor of 40 for a two-storey house in a built-up area, the doses accumulated in 36 hours for the ranges referred to in the U.S. Atomic Energy Commission Report (paragraph 84) would have been:—

| | | | |
|---|---|---|---|
| 190 miles downwind | 7½r | | 15 Megatons |
| 160 ,, ,, | 12½r | | Bravo 1954 |
| 140 ,, ,, | 20r | | |

which are all well below the lowest figure of 25r referred to in Table 1. At closer ranges along the axis of the fall-out, the doses accumulated in 36 hours would have been much higher, but over most of the contaminated area—with this standard of protection—the majority of those affected would have been saved from death, and even from sickness, by taking cover continuously for the first 36 hours.

## 5. Radiation sickness

Assume dose incurred in a single shift (3–4 hours) by the "average" man, over the whole body:—

| | |
|---|---|
| 25 roentgens | —No obvious harm. |
| 100 ,, | —Some nausea and vomiting. |
| 500 ,, | —Lethal to about 50 per cent. people (death up to 6 weeks later). |
| 800 ,, or more | —Lethal to all (death up to 6 weeks later). |

*Note:* If dose spread uniformly over 2–3 days, then 60 roentgens could be incurred with no more effect than 25 roentgens in a single exposure of 3–4 hours.

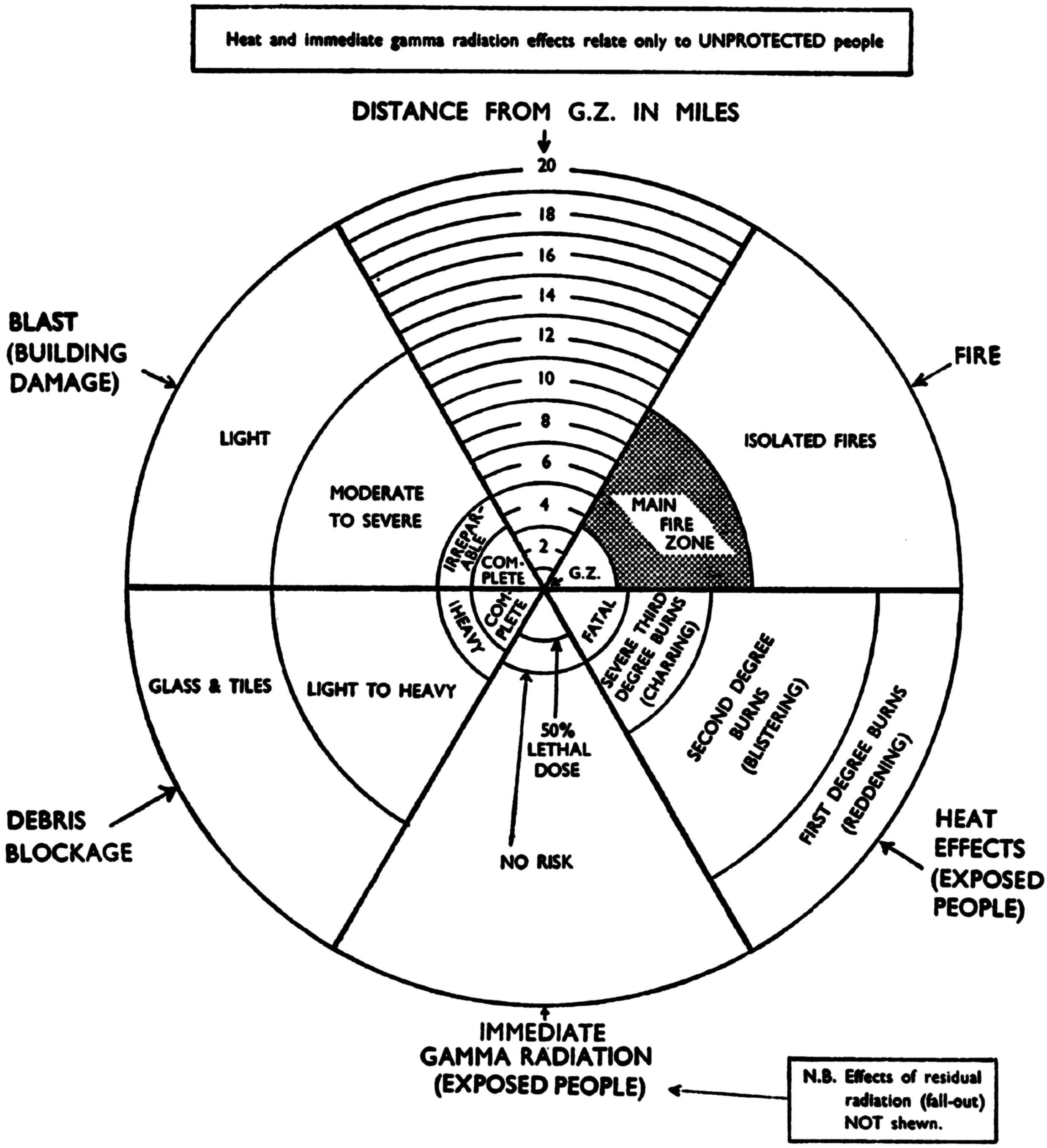



FIGURE 11

Combined effects (excluding residual radioactivity) from a 10 megaton ground burst bomb. Heat and immediate gamma radiation effects relate only to UNPROTECTED people.

HOME OFFICE
SCOTTISH HOME DEPARTMENT

MANUAL OF CIVIL DEFENCE

Volume I

PAMPHLET No. 2

# RADIOACTIVE FALL-OUT

## PROVISIONAL SCHEME OF PUBLIC CONTROL

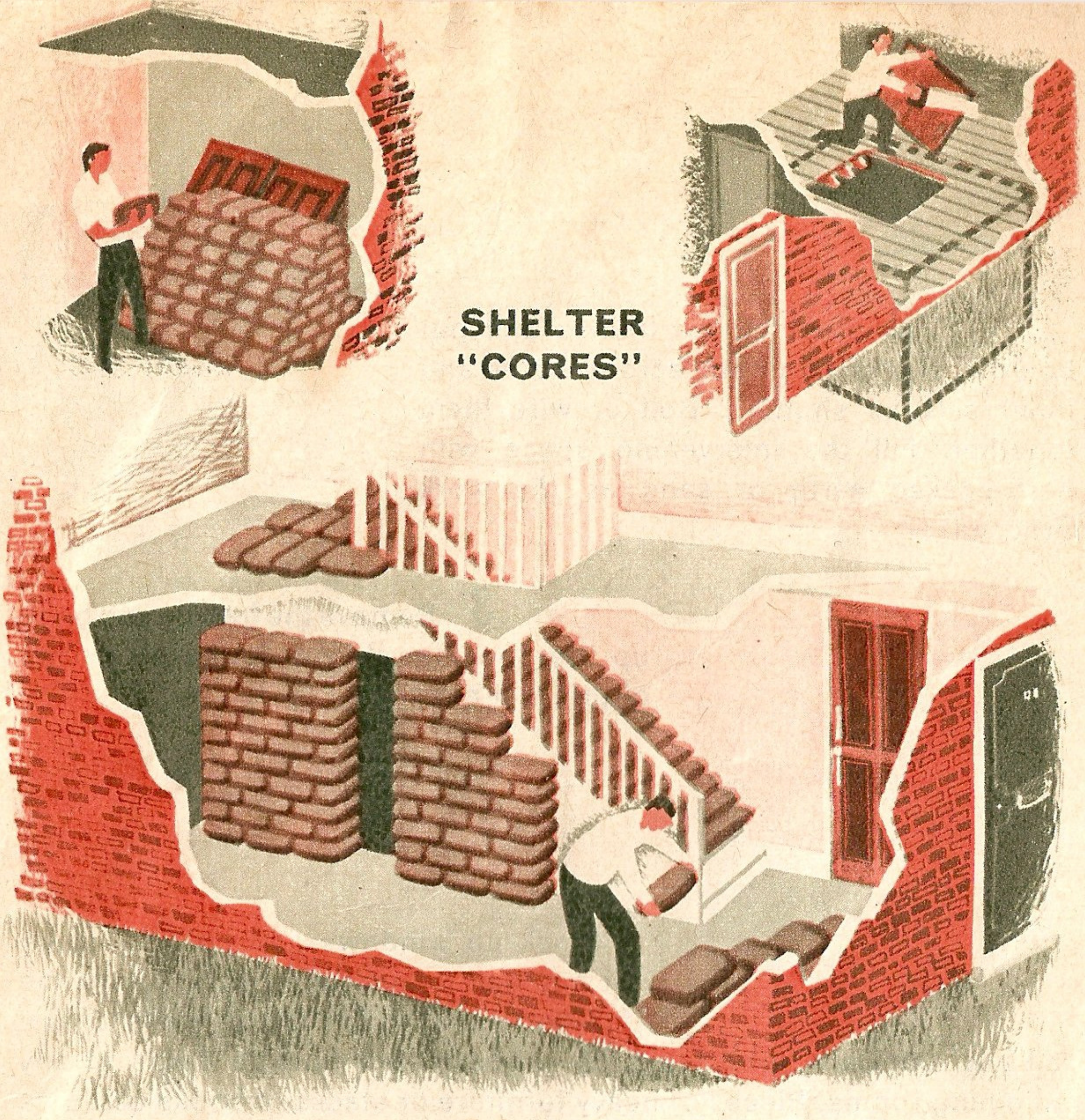
*LONDON*
HER MAJESTY'S STATIONERY OFFICE
1956

## Radioactive Fall-out—Summary of Provisional Control Zones

| Zone | Definition of Zone Boundaries | Range of Cumulative Doses in open at 48 hours | Summary of permissible and recommended action | Range of Cumulative Doses assuming observance of control rules |
|---|---|---|---|---|
| W | Outer: Limit of area placed under "Black Warning" (*see* Footnote).<br>Inner: 0·3 r.p.h. at 48 hrs. | Up to 80r | Complete release from refuge as soon as dose-rate fell to 0·3 r.p.h. or, if the rate had not reached that figure, when fall-out was complete. | At 48 hrs. Below 2r |
| X | Outer: 0·3 r.p.h. at 48 hrs.<br>Inner: 3 r.p.h. at 48 hrs. | 80–800r | Qualified release from refuge after 48 hrs.—indoor workers to follow normal occupations, but not to exceed 4 hrs. per day in the open. Outdoor workers to work half shifts for next five days. At the end of this period the zone would be normal, except that all would be advised to be out of doors as little as possible and not in any case to exceed 8 hrs. per day in the open for the next three months. | At 48 hrs. 2-20r<br>At 7 days 6-60r<br>At 5 wks. 12-120r<br>At 3 mths. 14-145r |
| Y | Outer: 3 r.p.h. at 48 hrs.<br>Inner: 10 r.p.h. at 48 hrs. | 800-2,800r | Release from refuge under stringent control after 48 hrs. For the next 12 days people should not leave their refuge for longer than necessary. Time in the open should not exceed 2 hrs. per day and time under cover, but not in refuge, a further 8 hrs. On this basis essential indoor workers should be able to get to their places of work, but outdoor work would remain suspended; a relaxation would be possible after the first fortnight and further easement in another three weeks. For the rest of the first year, however, people in this zone should not exceed 8 hrs. a day in the open. | At 48 hrs. 20-70r<br>At 14 days 50-170r<br>At 5 wks. 70-240r<br>At 3 mths. 95-330r |
| Z | 10 r.p.h. at 48 hrs. | Above 2,800r | All movement outside refuge accommodation in this zone would be dangerous. People should remain in refuge until instructions for clearance were given—they should then leave the zone by the quickest available route if they had means of transport or wait in their refuge to be collected if they had not. The clearance operation might start after 48 hrs. and removal from the zone would be for at least 3 months. | At 48 hrs.—Above 70r |

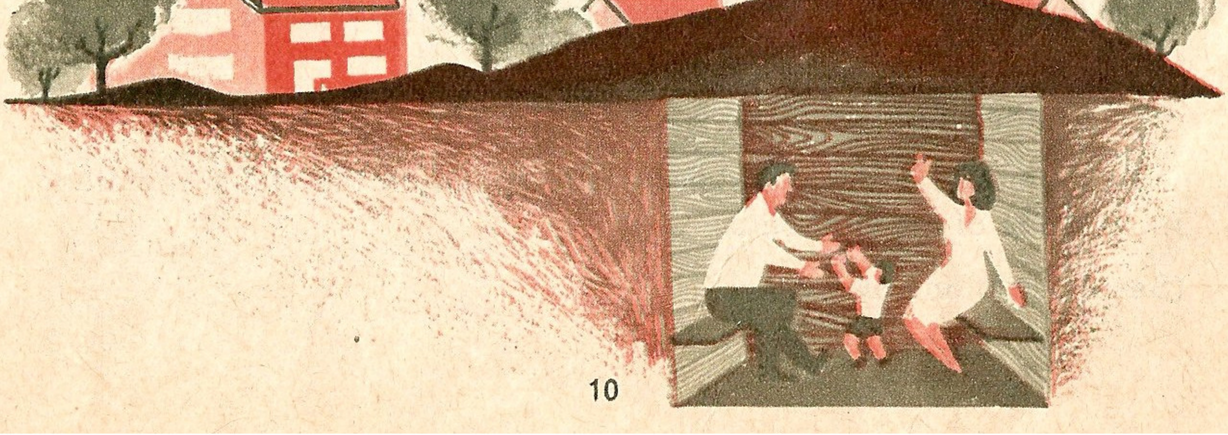
The initial Zone W boundary would be defined by the boundaries of a series of warning districts on the flanks of the fall-out. After 48 hrs. Zone W would for public control purposes have disappeared: its outer boundary would have moved during the period to coincide with the outer boundary of Zone X.

The question of defining an area extending in some places beyond Zone W in which there might be an agricultural hazard is being studied.




## Outdoor Fall-out Shelter

If it is impossible for you to prepare an indoor fall-out shelter, a trench dug outside your home would provide good protection. It should be deep enough to provide comfortable standing room and the sides should be shored up. After placing supports across the trench, cover the top with boards, metal sheets or concrete slabs, and heap earth on top. Leave a manhole-type entrance with a movable cover such as a dustbin lid. Keep a small ladder or a pair of household steps there.





UK CD Handbook 10, Advising the Householder, January 1963

Environmental Radiation Protection Factors
Provided by Civilian Vehicles

| Vehicle | Position | Protection Factor Range |
|---|---|---|
| Commercial bus (common type) | Throughout bus | 1.5-2.0 |
| Commercial bus (scenic cruiser type) | Throughout bus | 1.5-2.0 |
| School bus | Throughout bus | 1.5-1.8 |
| Passenger car | Passenger side (chest) | 1.5-1.7 |
| | Driver side | 1.5-1.7 |
| Pickup | Driver side | 1.9-2.1 |
| Crew cab | Driver side | 1.8-2.0 |
| | Back seat | 1.8-2.0 |
| Carryall | Driver side | 1.7-1.9 |
| | Rear side | 1.7-1.9 |
| 2-1/2-ton truck | Driver side | 1.8-2.0 |
| | Center of bed | 1.4-1.6 |
| 5-ton truck | Driver side | 2.0-2.2 |
| | Sleeper | 1.9-2.1 |
| Heavy Truck | Driver side | 1.4-1.6 |
| | Center of trailer | 2.7-3.1 |
| Fire truck | Driver side | 2.7-3.1 |
| | Standing area in back | 1.6-1.8 |
| Switch engine | Engineer's seat | 3.0-3.5 |
| Railway guard car | Sleeping quarters | 2.2-2.6 |
| | Kitchen area | 2.4-2.8 |
| | Center area | 2.0-2.4 |
| Heavy locomotive | Engineer's seat | 3.0-3.5 |

SOURCE: Z. G. Burson, "Environmental and Fallout Gamma Radiation Protection Factors Provided by Civilian Vehicles," <u>Health Physics</u>, <u>26</u>, 41-44, 1974.

# PERSONAL AND FAMILY SURVIVAL

## SM-3-11

"...the history of this planet and particularly the history of the 20th Century is sufficient to remind us of the possibilities of an irrational attack, a miscalculation, and accidental war, or a war of escalation in which the stakes by each side gradually increase to the point of maximum danger which cannot be either foreseen or deterred. It is on this basis that civil defense can be readily justified—as insurance for the civilian population in case of enemy miscalculation. It is insurance we trust will never be needed—but insurance which we would never forgive ourselves for foregoing in the event of catastrophe."

— President Kennedy, in May 1961

**Remove doors from their hinges and place them over supports**

**Drinking-water is required for survival. It is also useful as a shielding material. A collapsible children's swimming pool filled with water and located over the best corner of your basement will help improve the fallout protection. A bathtub, if suitably located, can also be used for this purpose.**

DEPARTMENT OF DEFENSE
OFFICE OF CIVIL DEFENSE

## Foreword

If the country were ever faced with an immediate threat of nuclear war, a copy of this booklet would be distributed to every household as part of a public information campaign which would include announcements on television and radio and in the press. The booklet has been designed for free and general distribution in that event. It is being placed on sale now for those who wish to know what they would be advised to do at such a time.

***May 1980***

*Protect and Survive*
ISBN 0 11 3407289

If Britain is attacked by nuclear bombs or by missiles, we do not know what targets will be chosen or how severe the assault will be.

If nuclear weapons are used on a large scale, those of us living in the country areas might be exposed to as great a risk as those in the towns. The radioactive dust, falling where the wind blows it, will bring the most widespread dangers of all. No part of the United Kingdom can be considered safe from both the direct effects of the weapons and the resultant fall-out.

The dangers which you and your family will face in this situation can be reduced if you do as this booklet describes.

# Planning for survival

## Stay at Home

Your own local authority will best be able to help you in war.
If you move away – unless you have a place of your own to go to or intend to live with relatives – the authority in your new area will not help you with accommodation or food or other essentials.
If you leave, your local authority may need to take your empty house for others to use.
So stay at home.

## Plan a Fall-out Room and Inner Refuge

The first priority is to provide shelter within your home against radioactive fall-out. Your best protection is to make a fall-out room and build an inner refuge within it.

## First, the Fall-out room

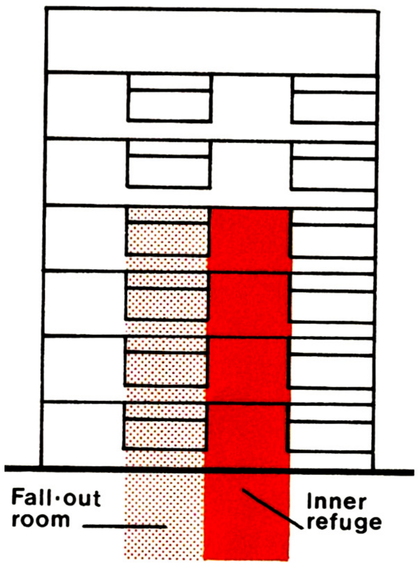
Because of the threat of radiation you and your family may need to live in this room for fourteen days after an attack, almost without leaving it at all. So you must make it as safe as you can, and equip it for your survival. Choose the place furthest from the outside walls and from the roof, or which has the smallest amount of outside wall. The further you can get, within your home, from the radioactive dust that is on or around it, the safer you will be. Use the cellar or basement if there is one. Otherwise use a room, hall or passage on the ground floor.

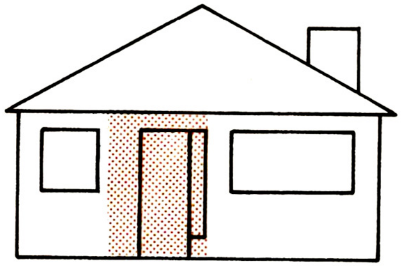
## Now the Inner Refuge

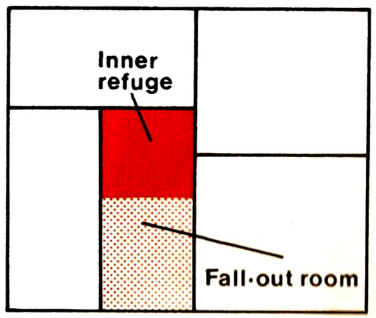
Still greater protection is necessary in the fall-out room, particularly for the first two days and nights after an attack, when the radiation dangers could be critical. To provide this you should build an inner refuge. This too should be thick-lined with dense materials to resist the radiation, and should be built away from the outside walls.

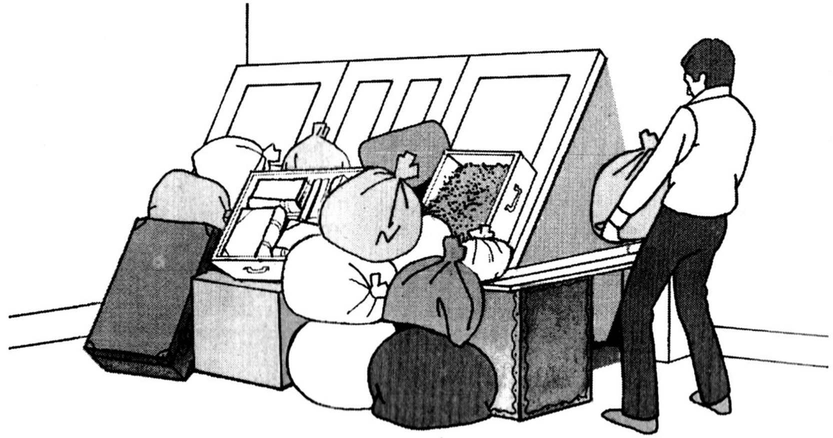
### Here are some ideas:

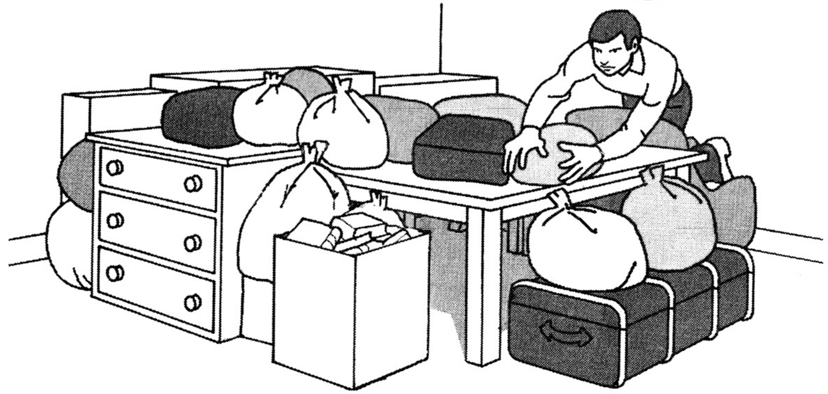
Make a 'lean-to' with sloping doors taken from rooms above or strong boards rested against an inner wall. Prevent them from slipping by fixing a length of wood along the floor. Build further protection of bags or boxes of earth or sand – or books, or even clothing – on the slope of your refuge, and anchor these also against slipping. Partly close the two open ends with boxes of earth or sand, or heavy furniture.



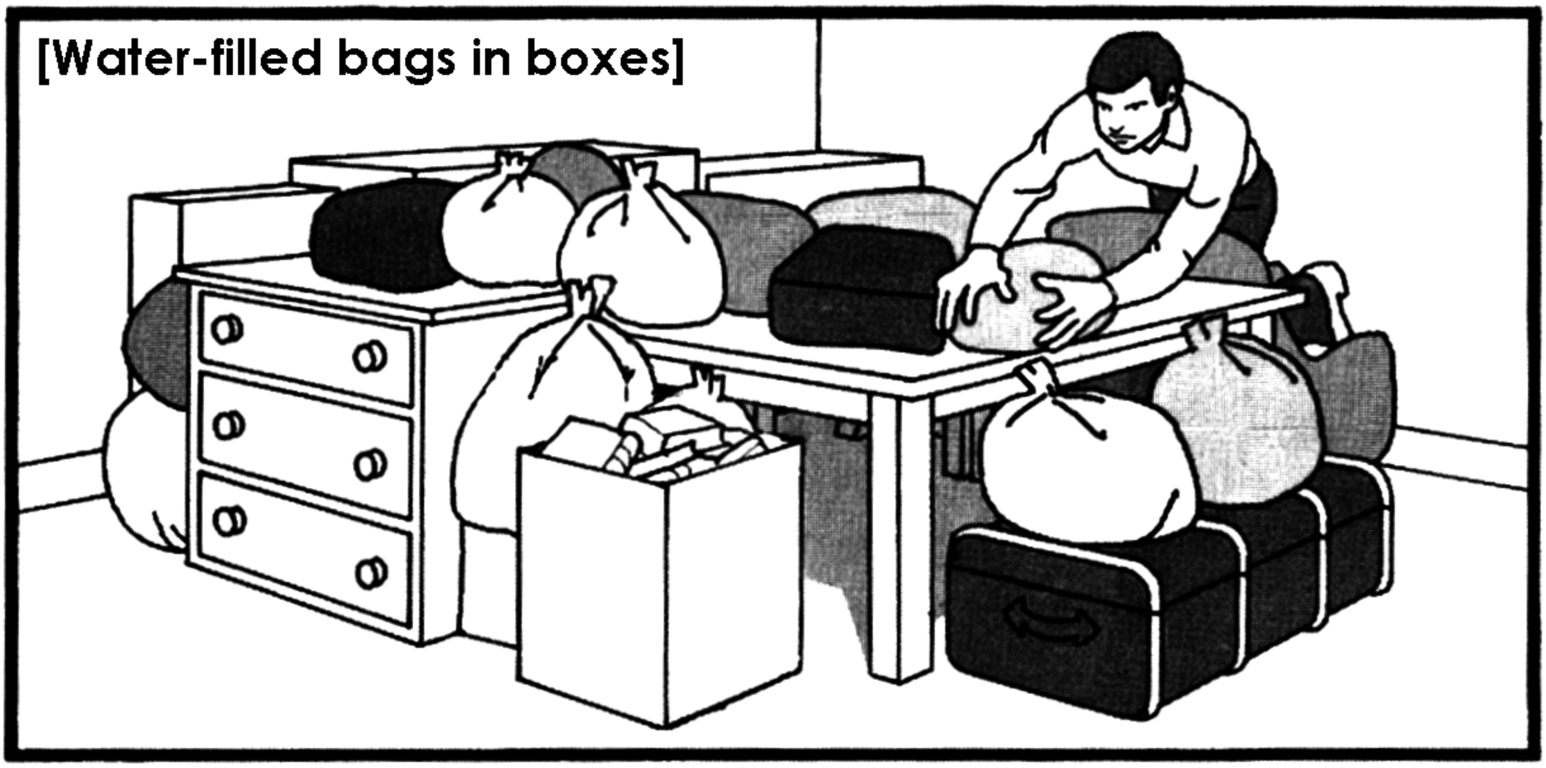







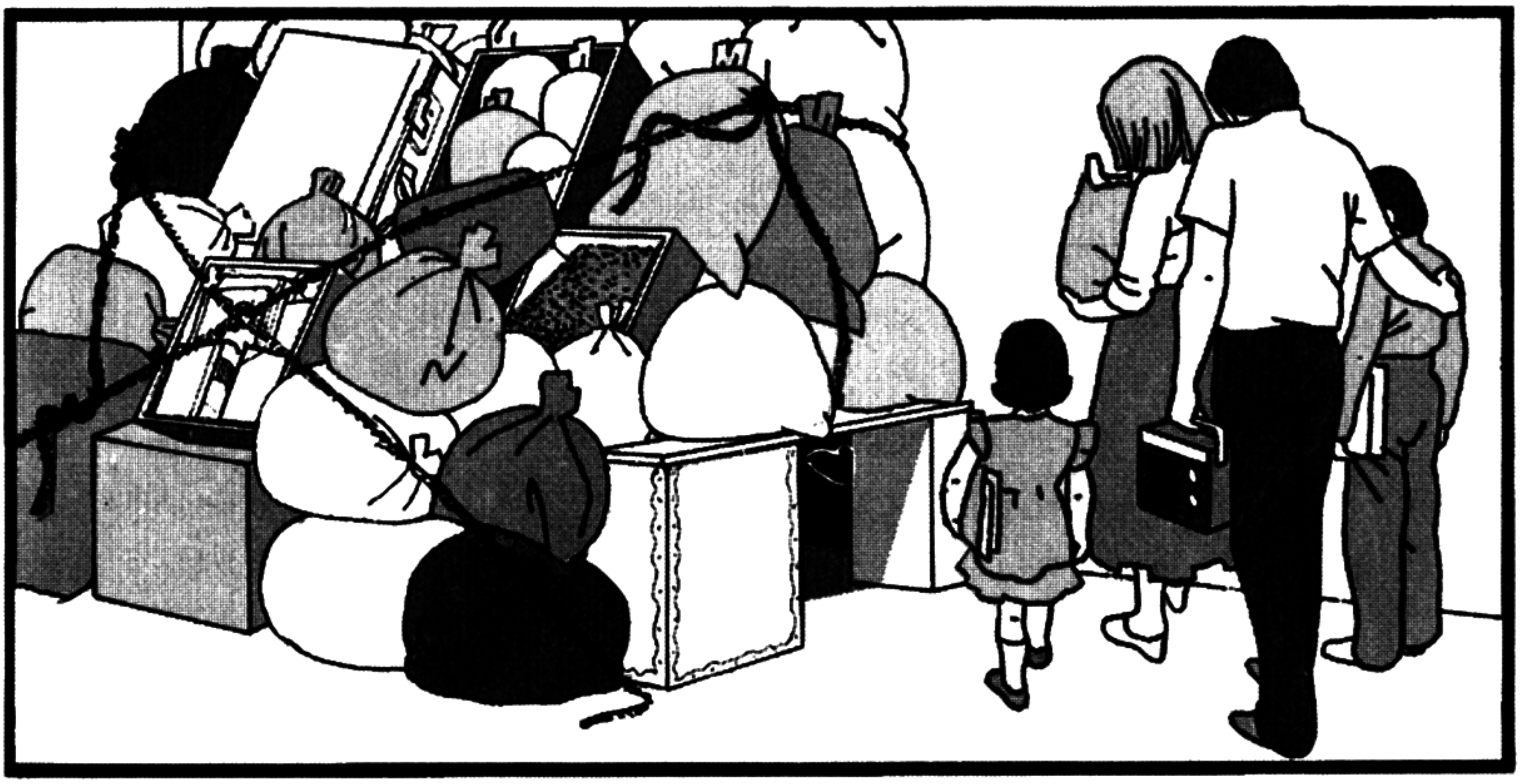
Protect and Survive
UK Government, May 1980



[Water-filled bags in boxes]

If there is structural damage from the attack you may have some time before a fall-out warning to do minor jobs to keep out the weather – using curtains or sheets to cover broken windows or holes.

If you are out of doors, take the nearest and best available cover as quickly as possible, wiping all the dust you can from your skin and clothing at the entrance to the building in which you shelter.



Proceedings of the Symposium
held at Washington, D. C.
April 19-23, 1965 by the
Subcommittee on Protective Structures,
Advisory Committee on Civil Defense,
National Academy of Sciences—
National Research Council

# Protective Structures

# for

# CIVILIAN POPULATIONS

1966

# MODEL ANALYSIS

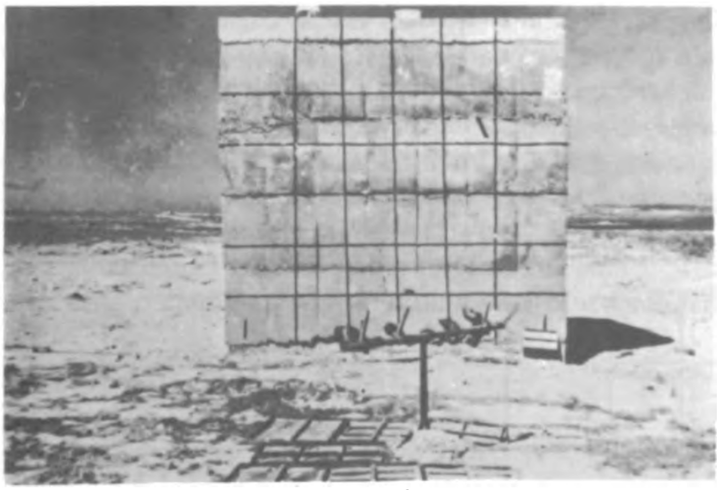
Mr. Ivor Ll. DAVIES
Suffield Experimental Station
Canadian Defense Research Board
Ralston, Alberta, Canada

Nuclear-Weapon Tests

In 1952 we fired our first nuclear device, effectively a "nominal" weapon, at Monte Bello, off northwest Australia. To the blast loading from this weapon we exposed a number of reinforced-concrete cubicle structures that had been designed for the dynamic loading conditions, and for which we made the best analysis of response we were competent to make at that time. Our estimates of effects were really a dismal failure. The structures were placed at pressure levels of 30, 10, and 6 psi, where we expected them to be destroyed, heavily damaged with some petaling of the front face, and extensively cracked, respectively. In fact, the front face of the cubicle at 30 psi was broken inwards; failure had occurred along both diagonals, and the four triangular petals had been pushed in. At the 10-psi level, where we had three cubicles, each with a different wall thickness (6, 9, and 12 in.), we observed only light cracking in the front face of that cubicle with the least thick wall (6 in.). The other two structures were apparently undamaged, as was the single structure at the 6-psi level.

In 1957, the first proposals were made for the construction of the underground car park in Hyde Park in London. The Home Office was interested in this project since, in an emergency, the structure could be used as a shelter. Consequently a request was made to us at Atomic Weapons Research Establishment (A.W.R.E.) to design a structure that would be resistant to a blast loading of about 50 psi, and to test our design on the model scale.

Using the various load-deformation curves obtained in this test, an estimate was made of the response of the structure to blast loading. Of particular interest was the possible effect of 100 tons of TNT, the first 100-ton trial at Suffield in Alberta.



10 p.s.i.

34 p.s.i.

Dynamic tests, Monte Bello cubicles.

A total of seven more models was made; six were shipped to Canada and placed with the top surface of the roof flush with the ground and at positions where peak pressures of 100, 80, 70, 60, 50, and 40 psi were expected. The seventh model was kept in England for static testing at about the time of firing. The results were not as expected. In the field, the four models farthest from the charge were apparantly undamaged; we could see no cracking with the eye, nor did soaking the models with water reveal more than a few hair cracks. The model nearest the charge was lightly cracked in the roof panels and beams, and one of the columns showed slight spalling at the head. This model had been exposed to a peak pressure of 110 psi.

# THE PROTECTION AGAINST FALLOUT RADIATION AFFORDED BY CORE SHELTERS IN A TYPICAL BRITISH HOUSE

**Daniel T. Jones**
**Scientific Adviser, Home Office, London**

Protective Factors in a Sample of British Houses (Windows Blocked)

| Protective Factor | Percentage of Houses |
|---|---|
| < 25 | 36% |
| 25-39 | 28% |
| 40-100 | 29% |
| > 100 | 7% |

"A very much improved protection could be obtained by constructing a shelter core. This means a small, thick-walled shelter built preferably inside the fallout room itself, in which to spend the first critical hours when the radiation from fallout would be most dangerous."(1)

The full-scale experiments were carried out at the Civil Defense School at Falfield Park.(2)

In the staircase construction, the shelter consisted of the cupboard under the stairs, sandbags being placed on treads above and at the sides.

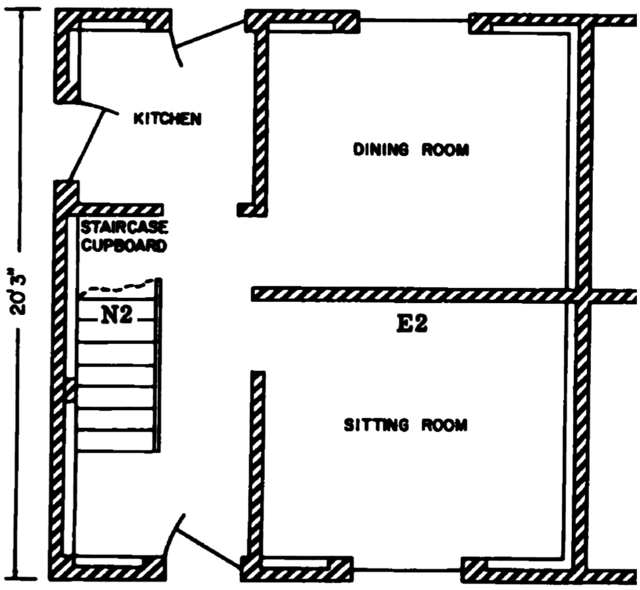
A 93 curies cobalt-60 source was used.

| 9 in. brick walls<br>The windows and doors were not blocked | Position | contribution $r/hr/c/ft^2$<br>Ground | Roof | Protective Factor |
|---|---|---|---|---|
| House only | E2 | 15.0 | 8.4 | 21 |
| Lean-to | E2 | 10.4 | 2.4 | 39 |
| Staircase cupboard: | | | | |
| Stairs only sandbagged | N2 | 29.2 | 5.3 | 14 |
| Stairs and outer wall sandbagged | N2 | 16.4 | 4.6 | 24 |
| Stairs, outer wall, kitchen wall and corridor partition sandbagged | N2 | 8.8 | 1.8 | 47 |

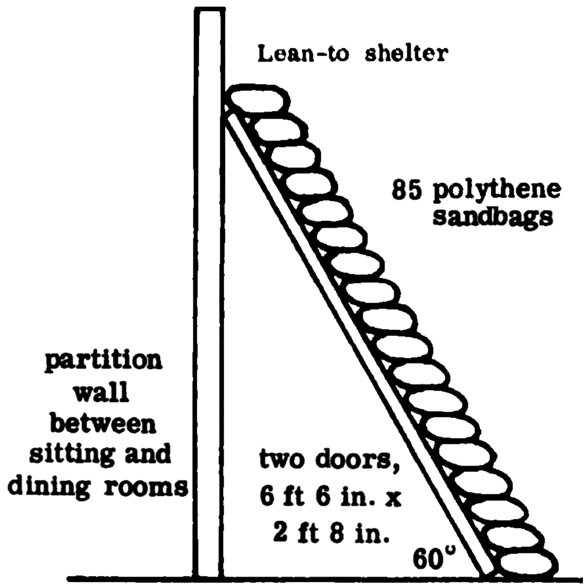
1. Civil Defence Handbook No. 10, HMSO, 1963.

2. Perryman, A. D., Home Office Report CD/SA 117.

1. Six sandbags per tread, and a double layer on the small top landing. 96 sandbags were used.
2. As (1), together with a 4-ft-high wall of sandbags along the external north wall. 160 sandbags were used.
3. As (2), together with 4-ft-high walls of sandbags along the kitchen/cupboard partition wall and along the passage partition. 220 sandbags were used.




sandbags 24 in. x 12 in. when empty; 16 in. x 9 in. x 4 in. when filled with 25 lb of sand.




floor area 21 sq ft.

# BLAST AND OTHER THREATS

Harold Brode
The RAND Corporation, Santa Monica, California

## Chemical High-Explosive Weapons

As in past aerial warfare, bombs and missiles carrying chemical explosives to targets are capable of extensive damage only when delivered in large numbers and with high accuracy.

## Biological Warfare

Most biological agents are inexpensive to produce; their effective dissemination over hostile territories remains the chief deterrent to their effective employment. Twenty square miles is about the area that can be effectively covered by a single aircraft; large area coverage presents a task for vast fleets of fairly vulnerable planes flying tight patterns at modest or low altitudes. While agents vary in virulence and in their biologic decay rate, most are quite perishable in normal open-air environments. Since shelter and simple prophylactic measures can be quite effective against biological agents, there is less likelihood of the use of biological warfare on a wholesale basis against a nation, and more chance of limited employment on population concentrations —perhaps by covert delivery, since shelters with adequate filtering could insure rather complete protection to those inside.

## Chemical Weapons

Chemical weapons, like biological weapons, are relatively inexpensive to create, but face nearly insurmountable logistics problems on delivery. Although chemical agents produce casualties more rapidly, the greater amounts of material to deliver seriously limit the likelihood of their large-scale deployment. Furthermore, chemical research does not hold promise of the development of significantly more toxic chemicals for future use.

## Radiological Weapons

The advantages of such modifications are much less real than apparent. In all weapons delivered by missiles, minimizing the payload and total weight is very important. If the total payload is not to be increased, then the inclusion of inert material to be activated by neutrons must lead to reductions in the explosive yield. If all the weight is devoted to nuclear explosives, then more fission-fragment activity can be created, and it is the net difference in activity that must be balanced against the loss of explosive yield. As it turns out, a fission explosion is a most efficient generator of activity, and greater total doses are not achieved by injecting special inert materials to be activated.

Perret, W.R., Ground Motion Studies at High Incident Overpressure, The Sandia Corporation, Operation PLUMBBOB, WT-1405, for Defense Atomic Support Agency Field Command, June 1960.

## The Neutron Bomb

The neutron bomb, so called because of the deliberate effort to maximize the effectiveness of the neutrons, would necessarily be limited to rather small yields—yields at which the neutron absorption in air does not reduce the doses to a point at which blast and thermal effects are dominant. The use of small yields against large-area targets again runs into the delivery problems faced by chemical agents and explosives, and larger yields in fewer packages pose a less stringent problem for delivery systems in most applications. In the unlikely event that an enemy desired to minimize blast and thermal damage and to create little local fallout but still kill the populace, it would be necessary to use large numbers of carefully placed neutron-producing weapons burst high enough to avoid blast damage on the ground, but low enough to get the neutrons down. In this case, however, adequate radiation shielding for the people would leave the city unscathed and demonstrate the attack to be futile.

The thermal radiation from a surface burst is expected to be less than half of that from an air burst, both because the radiating fireball surface is truncated and because the hot interior is partially quenched by the megatons of injected crater material.

SUPERSEISMIC GROUND-SHOCK MAXIMA
(AT 5-FT DEPTH)

Vertical acceleration: $\alpha_{vm} \simeq 340\,\Delta P_s/C_L \pm 30$ per cent. Here acceleration is measured in g's and overpressure ($\Delta P_s$) in pounds per square inch. An empirical refinement requires $C_L$ to be defined as the seismic velocity (in feet per second) for rock, but as three fourths of the seismic velocity for soil.

OUTRUNNING GROUND-SHOCK MAXIMA
(AT ~10-FT DEPTH)

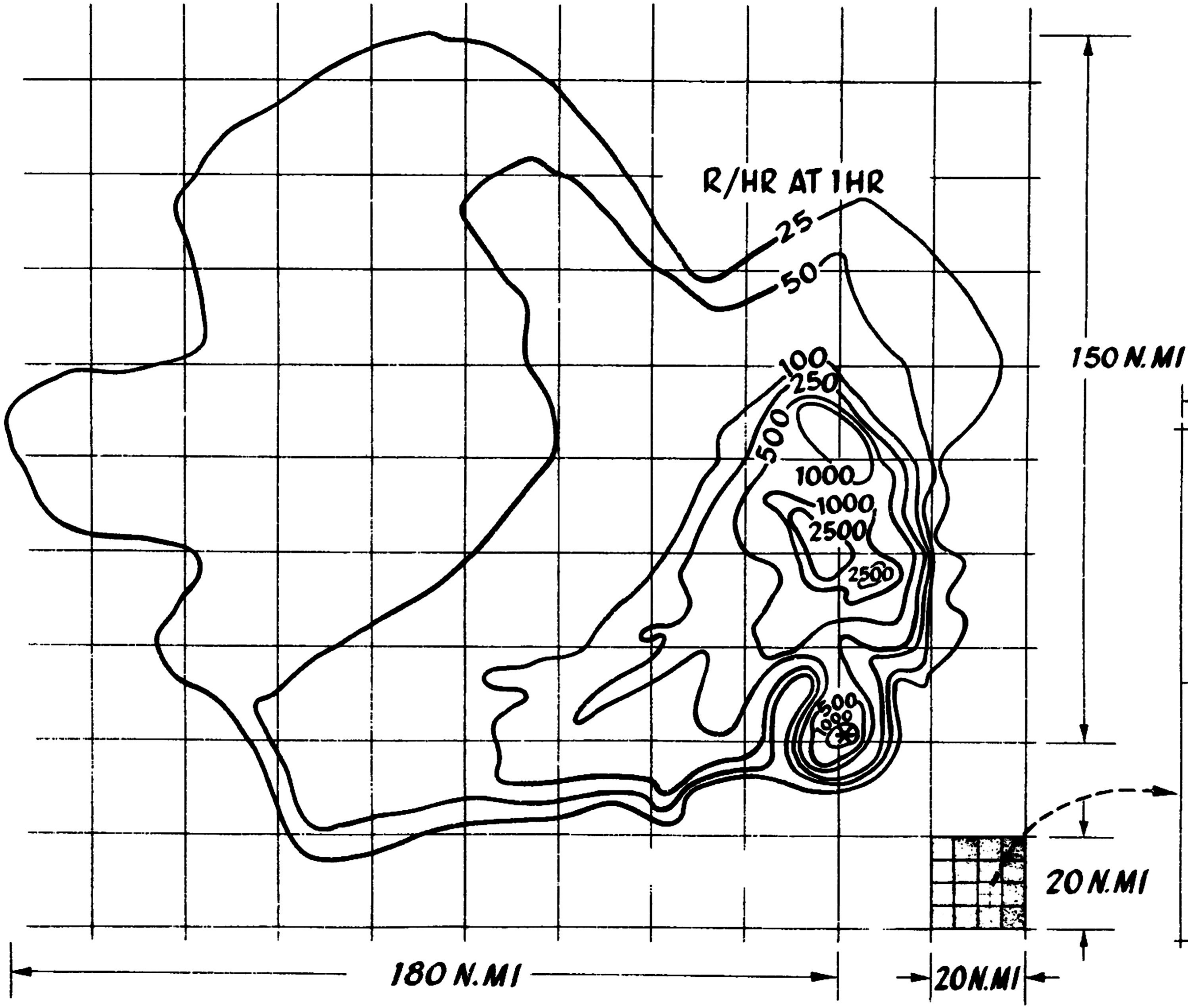
Vertical acceleration: $\alpha_{vm} \simeq 2 \times 10^5/C_L r^2$ + factor 4 or -factor 2. Acceleration is measured in g's, and r is the scaled radial distance—i.e., $r = R/W^{1/3}$ kft/(mt)$^{1/3}$.

Data taken on a low air-burst shot in Nevada indicate an exponential decay of maximum displacement with depth. For the particular case of a burst of ~ 40 kt at 700 ft, some measurements were made as deep as 200 ft below the surface of Frenchman Flat, a dry lake bed, which led to the following approximate decay law, according to Perret.

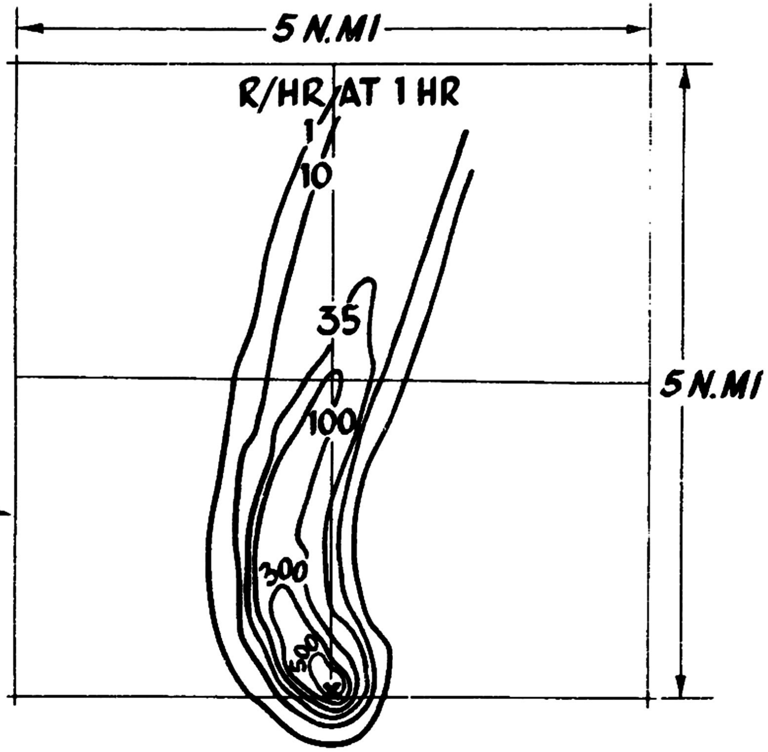
$\delta = \delta_0 \exp(-0.017D)$,

where $\delta$ represents the maximum vertical displacement induced at depth D, $\delta_0$ is the maximum displacement at the surface, and D is the depth in feet.

# COMPARISON of FALLOUT CONTOURS




5 MT BURST




1 KT BURST

MINISTRY OF HOME SECURITY

# AIR RAIDS

## What You must know
## What You must do



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# FOREWORD

BY

## SIR JOHN ANDERSON, G.C.B., G.C.S.I., G.C.I.E., M.P.

*Minister of Home Security.*

This book is written to help you and your family and your friends.

There has been built up in the last few years a vast organisation for Civil Defence; and, thanks to the devotion of a great army of volunteers, the services which it comprises have been welded into a highly efficient force. This organisation is briefly described in the first chapter, which has been included in this book for two reasons; first, because I may, in the near future, have to call on many of you to give some part of your time to one or other of these services, and secondly, because you may need the help of the services and should therefore understand something about them.

But the Civil Defence services alone cannot protect you from the consequences of air raids. Your own protection and the protection of your family must, in large measure, depend on your taking certain necessary precautions. You can yourself do much to minimise risk to yourself and to those dependent on you.

A great deal of information has been collected as a result of experience gained in actual air raids, and from this and from research and experiment the basic principles on which the protection of life and limb and property depends have been worked out and are set down here for your guidance. They are simple to understand and easy to carry out; and if you will act on them you will be able to face the dangers of air raids with the sure conviction that you have done all in your power for the safety of those depending on you, and with the calmness and assurance that come from a knowledge of the way in which these dangers can be met. In this way you will be helping not only yourself, but the Nation, for it is through the strengthening of your powers of resistance that the people of this country will be enabled to defeat every attempt the enemy may make to weaken its morale and paralyse its war effort.

In this war every man and woman is in the front line. A soldier at the front who neglects the proper protection of his trench does more than endanger his own life; he weakens a portion of his country's defences and betrays the trust which has been placed in him. You, too, will have betrayed your trust if you neglect to take the steps which it is your responsibility to take for the protection of yourself and your family.

This is a contribution to the winning of final victory which you personally can make and which no one else can make for you. I am confident that you will make it.

John Anderson

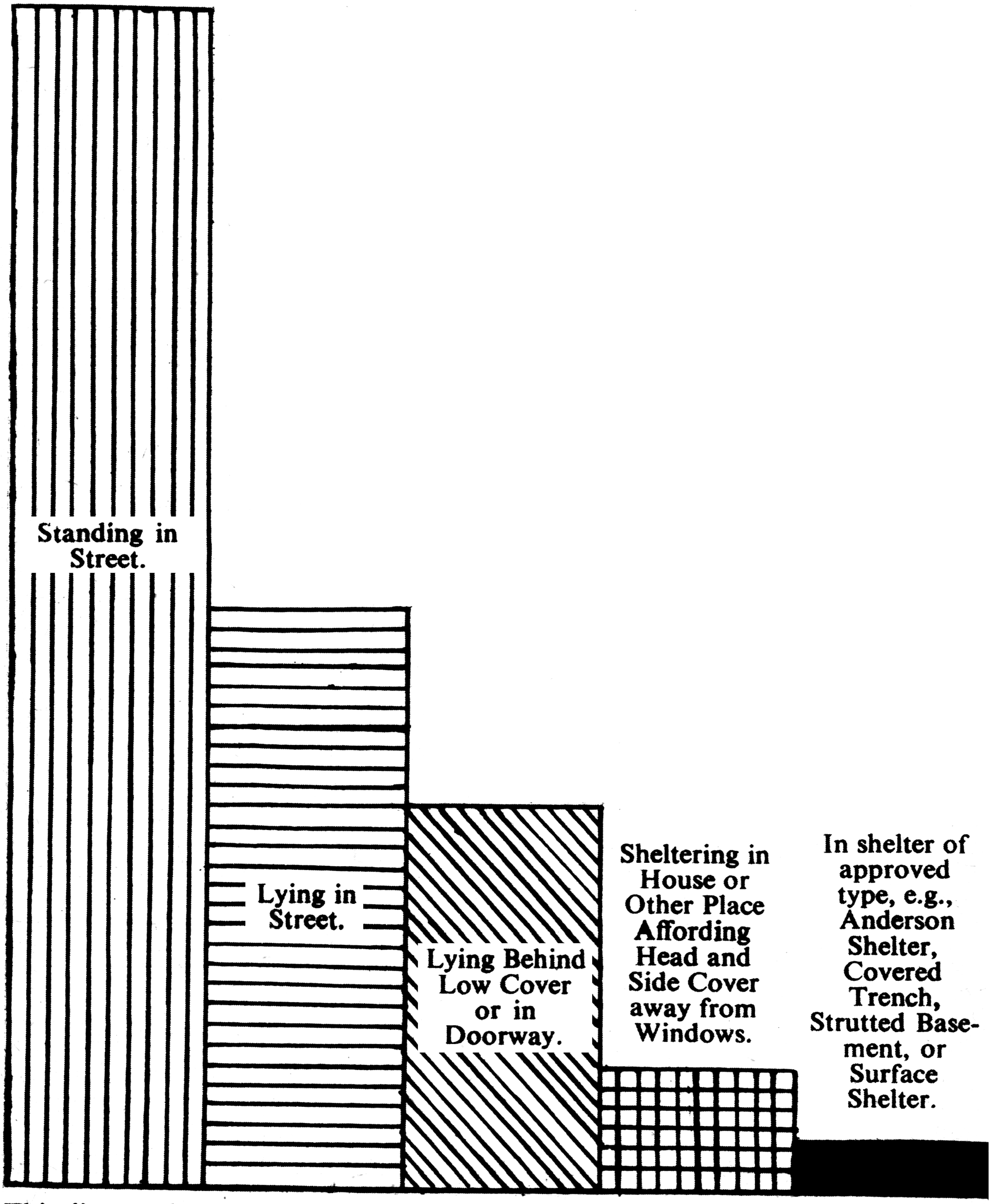
*Ministry of Home Security.*

*June*, 1940.

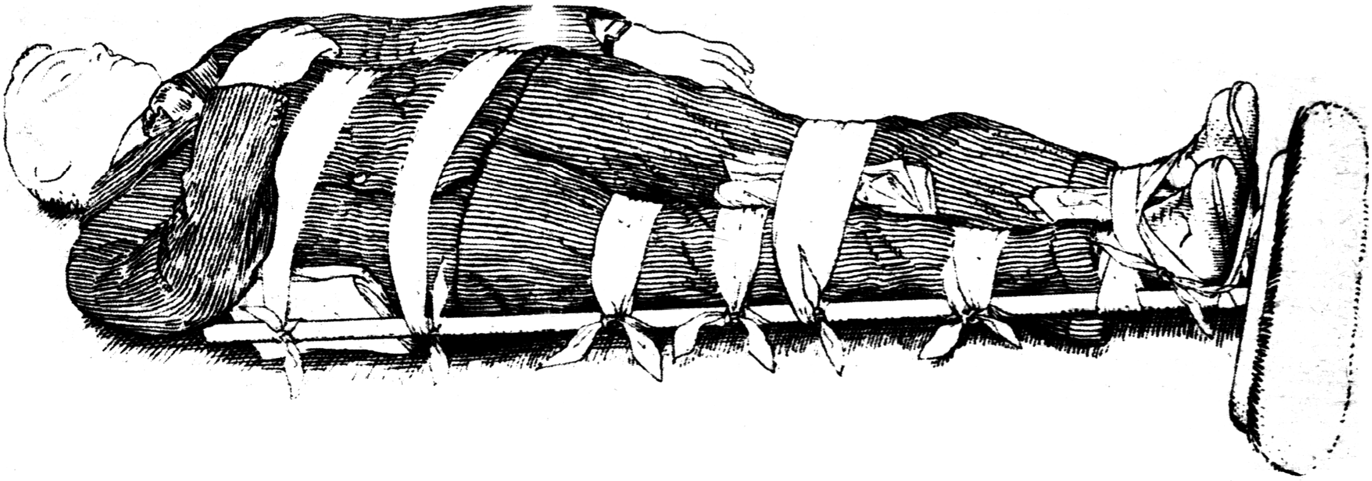
*Tools.*

A number of tools such as picks, shovels, and crowbars should be kept in a shelter to be used in forcing a way out if the occupants are trapped. When the accommodation is being fitted out, it should be discovered where the weakest part of the structure is, or where it would be most suitable to work, should it become necessary to break a way out. This position should be clearly marked for the benefit of all.

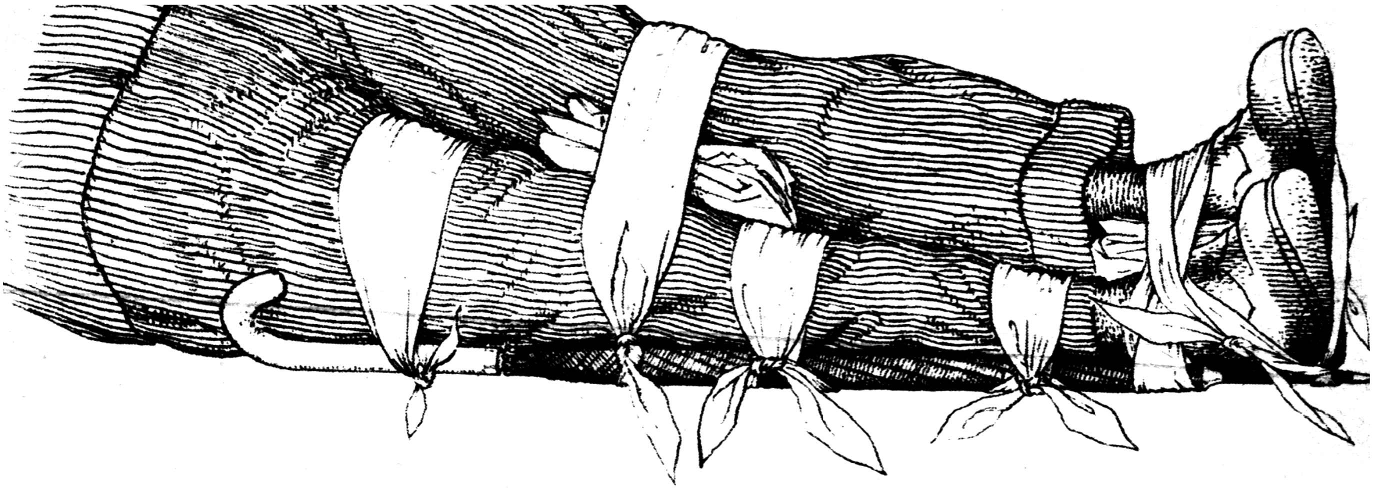





**This diagram is based on a large number of reports of the results of recent air raids and is an approximate indication of the difference in the degree of risk resulting from taking cover in various ways.**

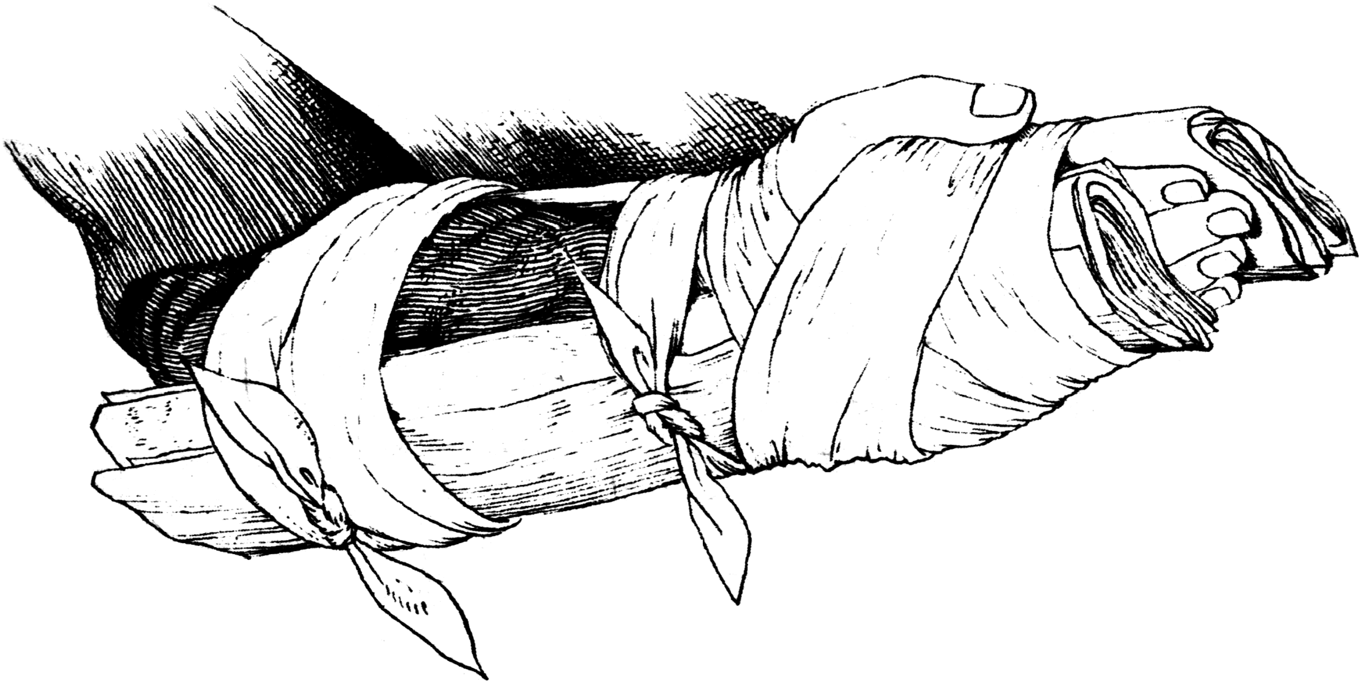


A broom used as a thigh splint by placing the handle along the injured limb, with the head of the broom at the feet. Loosely folded pieces of newspaper or other material may be used as padding, placed between the ankle and knee joints, and also at the hip.



*Sketch II.*—Simple fracture through middle third of tibia (shin-bone).

The illustration shows an umbrella used as a splint. The ankles and knee joints are padded with loosely folded newspaper.



*Sketch III.* Simple fracture through one or both bones of the forearm.

The illustration shows the use of newspaper, folded to the approximate size of an arm splint, so as to be stiff enough to give rigid support.

# AN ANALYSIS OF 259 OF THE RECENT FLYING-BOMB CASUALTIES

BY

R. C. BELL, M.B., M.R.C.S.

*Resident Surgical Officer to an E.M.S. Hospital*

In all we dealt with 222 out-patients and 259 in-patients, with 18 deaths. Our story began in June, 1944, when the first large incident occurred near by. Twenty-six casualties were admitted and 12 required theatre treatment. This proportion remained fairly constant throughout the series. Altogether we had 83 theatre cases out of 259 admissions, and had to send 35 cases on untreated, most of whom required the theatre. In this first incident no fewer than 16 of the casualties were due to flying glass. It was noticeable how the proportion of glass injuries dropped as the importance of taking adequate cover was realized, while the percentage of crush injuries increased from people being trapped by falling masonry.

## A. Flying Glass

This was the most frequent cause of injury, totalling over 100 casualties in all. Many included severe damage to the eyes. It is noticeable that most of the injuries were above the nipple line, chiefly of the face and neck: a large proportion were received when looking out of windows—a modern version of curiosity killing the cat. We had five cases of perforating wounds of both eyes and ten perforating wounds of one eye. The globe was usually completely destroyed. Many of these injuries were avoidable, and therein lay their great sadness.

The penetrating power of flying glass is, in the main, low. It is unusual for it to pierce the deep fascia: usually it lies just under the skin in the fat, but when present in hundreds of pieces it presents a problem which has not yet acquired a satisfactory solution ; nor has the condition made its way into the textbooks of war surgery.

TABLE I.—*Glass*

| Description | No. | Remarks | Deaths |
|---|---|---|---|
| Lacerations of face, scalp, and neck .. | 77 | 19 T | — |
| Perforating wounds of eye .. .. | 15 | 5 cases bilateral<br>2 T | — |
| Cut hands .. .. .. .. | 9 | | |
| Severe multiple lacerations .. .. | 6 | 1 T | 1 |
| Other injuries .. .. .. .. | 5 | — | — |

## Number and Classification of Official Evacuees in Great Britain in 1939 and 1940

| 900,000 of the 1.5 million returned to the target areas after four months of war. | September, 1939 | | January, 1940 | |
|---|---|---|---|---|
| | Number | Percentage Distribution | Number | Per cent of Those in September, 1939 |
| 1. Unaccompanied school children | 826,959 | 56.1 | 457,600 | 55 |
| 2. Mothers and accompanied children | 523,670 | 35.5 | 64,900 | 12 |
| 3. Expectant mothers | 12,705 | 0.9 | 1,140 | 9 |
| 4. Blind persons, cripples, and other special classes | 7,057 | 0.5 | 2,440 | 35 |
| 5. Teachers and helpers | 103,000 | 7.0 | 46,500 | 45 |
| Total | 1,473,391 | 100.0 | 572,580 | 39 |

Source: R. M. Titmuss, *Problems of Social Policy* (London: H.M. Stationery Office, 1950), pp. 103 and 172.

# Effectiveness of Some Civil Defense Actions in Protecting Urban Populations (u)

## Appendix B of Defense of the US against Attack by Aircraft and Missiles (u)

**ORO-R-17, Appendix B**



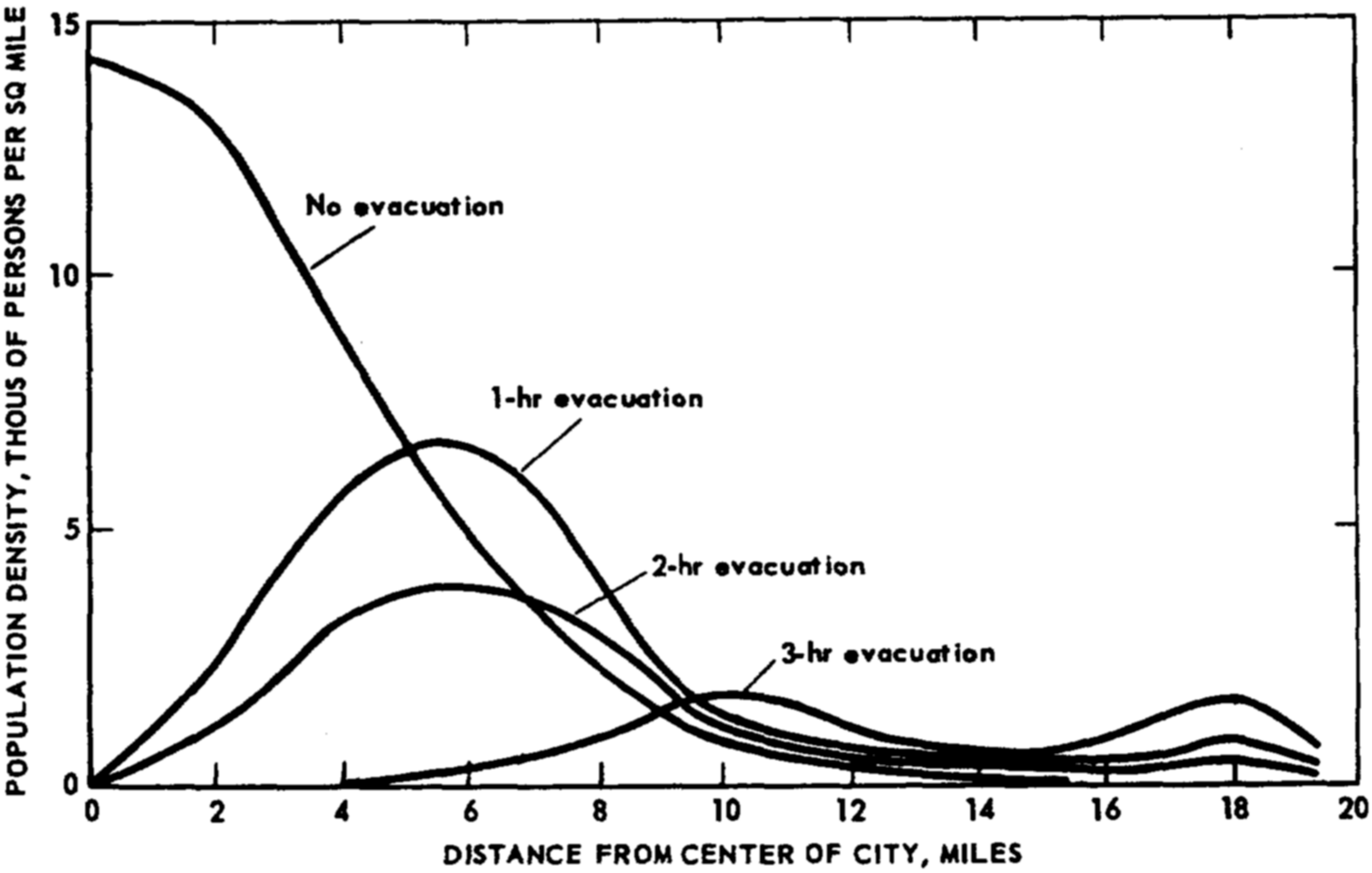



Fig. 10 — Population Density of Washington Target as Function of Distance from Center of City for Three Evacuation Times

Robert Scheer

# WITH ENOUGH SHOVELS: Reagan, Bush & Nuclear War

"Dig a hole, cover it with a couple of doors and then throw three feet of dirt on top... It's the dirt that does it... if there are enough shovels to go around, everybody's going to make it."

—T. K. Jones, Deputy Under Secretary of Defense for Strategic and Theater Nuclear Forces

"President Ronald Reagan had been in office less than a year when he approved a secret plan for the United States to prevail in a protracted nuclear war. This secret plan, outlined in a so-called National Security Decision Document, committed the United States for the first time to the idea that a global nuclear war can be won."

With these words Robert Scheer, the distinguished national reporter for the *Los Angeles Times*, begins this astonishing revelation of how a handful of Cold War ideologues—led by the President himself—have reversed the longstanding American assumption that nuclear war means mutual suicide.

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Robert Scheer's aim in *With Enough Shovels* is to expose the deadly course on which we are now embarked, a course that categorically rejects the strategic assumptions that prevailed from Presidents Eisenhower through Carter and that sustained the Nixon-Kissinger program of détente—a program which our current leaders call "appeasement."

Leon Gouré

# WAR SURVIVAL IN SOVIET STRATEGY

USSR
CIVIL DEFENSE

With a Foreword by
AMBASSADOR FOY D. KOHLER

SECRET CIA report leaked to Reagan in 1979

integrated city and rural civil defense exercises. One exercise of this type occurred in 1975 at Lytkarino, a town of 40,000 people near Moscow and a probable relocation site for Muscovites. According to Soviet publications, thousands of people participated, communication and reconnaissance operations were conducted, and shelters were occupied by local workers. Another 1975 exercise, in Tul'skaya Oblast, involved the city of Kimovsk in Kimovskiy Rayon; this was known as an "integrated rayonal exercise." There may

**LEON GOURÉ** is a Professor of International Studies and Director of Soviet Studies at the Center for Advanced International Studies at the University of Miami. A graduate of New York University, Columbia University School of International Affairs and Russian Institute, and Georgetown University, he is the author of *Civil Defense in the Soviet Union, The Siege of Leningrad,* and *Soviet Civil Defense 1969-70*. He has also co-authored *Soviet Strategy for the Seventies: From Cold War to Peaceful Coexistence, The Role of Nuclear Forces in Current Soviet Strategy,* and *Soviet Penetration of Latin America* among others.

1st printing .................... April 1976

2nd printing .................. August 1976

# *Foreword*

**by Foy D. Kohler**

Dr. Leon Gouré has devoted many years of study to Soviet civil defense and other war-survival policies and activities in the USSR. The area was one of his specialties while serving as a Senior Analyst for the RAND Corporation from 1951 to 1969, and he has continued his researches since joining the University of Miami in 1969 as Director of Soviet Studies and Professor in the Center for Advanced International Studies.



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As a part of our work program for this larger undertaking, the Center has held a series of special conferences wherein we have subjected our methodology and research findings to critical review by outside experts, including authoritative academic and governmental specialists on Soviet affairs and high-ranking policy-action officers from Defense, State and other agencies directly concerned with U.S.-Soviet relations.

At two of these conferences, special attention has been given to the Soviet war-survival problem: One in June 1975 included an exploration of how war-survival capabilities fit into the Soviet appraisal of the present and future "correlation of world forces." The second, held in January 1976, included a thorough examination of the implications for U.S. security interests and U.S. policy choices of what Moscow is actually doing in the war-survival area.



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Nearly all of the experts at our conference viewed the reasoning behind the overkill concept as "absurd." One cited as an example an article in the April 6, 1975 *Bulletin of the Atomic Scientists* in which the author argued that with its present stockpile of nuclear weapons the U.S. could destroy the world's population "twelve times over." The author's calculation was arrived at by multiplying the casualties per kiloton in Hiroshima and Nagasaki by the total number of kilotons in the U.S. nuclear arsenal and then dividing by the number of people living in the world. Such a calculation was characterized as completely misleading. Leaving aside such questions as how many U.S. weapons would survive a Soviet attack on this country and how many of the residue could be delivered on target, "it implies that means can be devised to collect the entire target population into the same density as existed in Hiroshima and Nagasaki and keep them in a completely unwarned and hence vulnerable posture. A statement of identical validity is that the world's inventory of artillery shells, small arms ammunition, or for that matter, kitchen knives or rocks can kill the human population several times over."

It was recalled that more than 10 billion pounds of TNT was dropped on Germany, Japan and Italy during World War II. This equalled more than 50 pounds for every man, woman and child in the three countries. Arithmetically considered, the result should have been the total annihilation of one and all of these. During the Vietnam War, more than 25 billion pounds of TNT were dumped on North and South Vietnam (15 billion by air and some 10 billion by other means) for an average of some 730 pounds for each of a total population of 34 million and an average of 3,000 pounds for each person in prime target areas; yet the U.S. was unable to kill enough people or to disrupt economic life, transportation and communications sufficiently to even avoid a humilitating defeat in the war.



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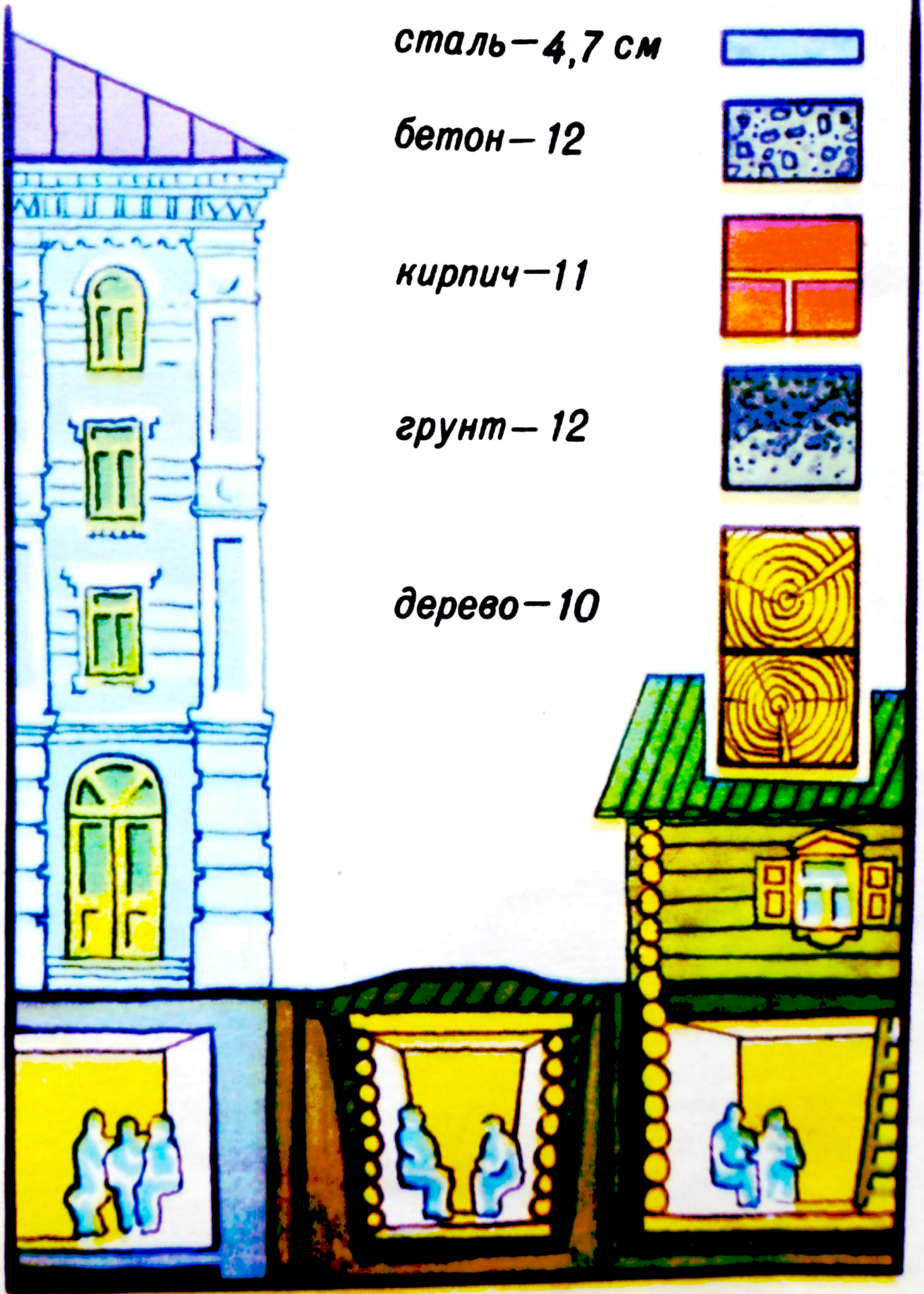
The basic issue, it was agreed, is how Moscow intends to exploit the situation politically. The Soviet risk calculations and ability to use its military power for political purposes are already being increasingly influenced by Moscow's perceptions of asymmetries between the U.S. and Soviet war-survival versus assured destruction capabilities. According to Moscow's view, these asymmetries are of great strategic significance for making Soviet power credible as a deterrent and as an instrument of policy. Soviet spokesmen have given clear indication of their awareness of the lack of a war-survival program in the U.S. as well as of the vulnerability of the U.S. arising from the high degree of concentration of its population and industry in a few areas of the country. It is inevitable, therefore, that the Soviet leadership will perceive this asymmetry between the Soviet Union and the U.S. as altering the balance of forces in Moscow's favor, and as affecting the credibility of the respective strategic deterrence and war-fighting postures of the two countries.

In effect, with its growing war-survival capability, the Soviet Union could well conclude that the U.S. threat of "massive retaliation" has no credibility except as an act of sheer desperation. In crisis situations, this factor could decisively influence both sides' risk calculations and consequently their relative ability and willingness to hold a hard line. The Soviet Union could confront the U.S. with its ability to keep Soviet population and resource losses within acceptable limits, all the more so if it carries out the evacuation of its cities, as against the certainty of U.S. losses of 50 percent or more of its population and of a very large portion of its industry. This would place the U.S. at a great disadvantage in the management of the crisis and in its negotiations with the Soviet Union. Instead of a "balance of terror" which equally restrains both sides, the "terror" would be mainly on the part of the U.S. and, faced with the possibility of national "suicide," the public reaction to it would be likely to deprive the President of any flexibility in his policy choices in dealing with Moscow.

# ЗАЩИТНЫЕ СВОЙСТВА МАТЕРИАЛОВ

**Экспозиционную дозу радиации ослабляют вдвое материалы толщиной**



~~Secret~~

Interagency
Intelligence
Memorandum

CIA HISTORICAL REVIEW PROGRAM
RELEASE AS SANITIZED

# Soviet Civil Defense

~~Secret~~

NIO IIM 76-041
November 1976

Copy № 404

— *Basement*—shelters created by adapting the basement areas of residential, government, and industrial structures, primarily for protection against fallout. (See Figure 12.)

— *Subways*—shelters provided by using the subway tunnels in major Soviet cities. The degree of protection against blast varies within subways, but all afford good protection against fallout. (See Figure 13.)

— *Expedient or hasty*—shelters built with materials readily available during the period immediately prior to a nuclear attack. (See Figure 14.)

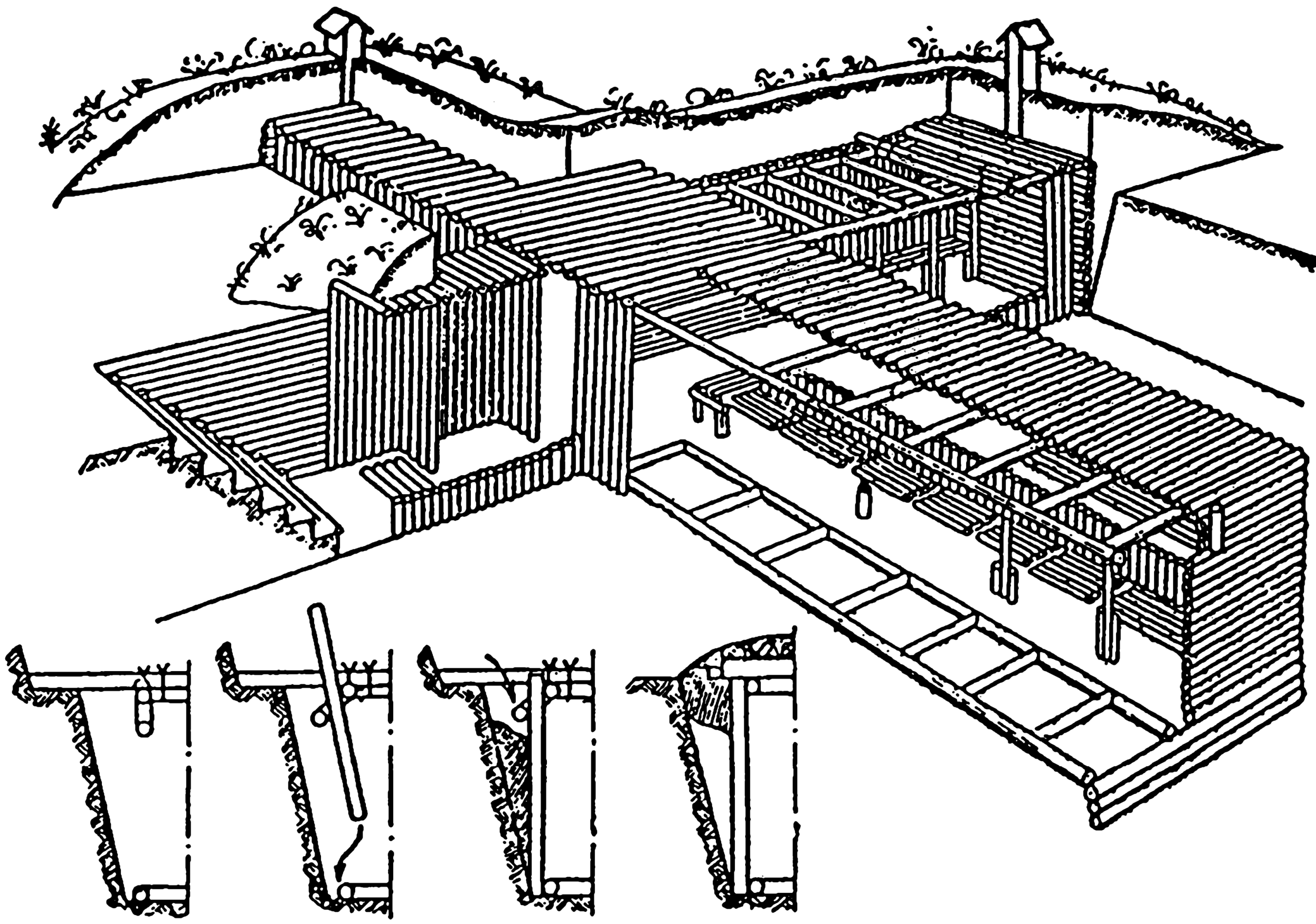
112. These several types of Soviet shelters offer varying degrees of protection against blast and fallout. According to Soviet planning, the type of shelter, its location, and the protection afforded are functions of the priority assigned to the survival of the protected personnel, the likelihood of direct attack or proximity to a target, and the availability of suitable structures that could be adapted as shelters.

113. Detached, bunker-type shelters, adaptable and built-in basement shelters, and subways are available for the protection of both essential workers and the general population. Dual-purpose shelters are also used as underground garages, clubs, and theaters which could be converted quickly to civil defense use.

114. Soviet writings and human sources have also referred to the use of various types of expedient, or temporary, shelters for protection from fallout. They consist of trenches lined with readily available materials and covered with earth. These shelters, which are described in more detail in paragraphs 139-141, are intended primarily for use by the rural population and by the urban population at dispersal and evacuation sites in rural areas. They could also be

Figure 14. Illustration of Soviet Expedient or Hasty Shelter

Diagrams such as this are provided in manuals widely distributed to the Soviet population for use in constructing hasty shelters in dispersal and evacuation areas.



569821 6 76

[USSR, "Antiradiation shelters in rural areas", 1972.]

or evacuee. In práctice, we believe—and emigrés have indicated—that conditions would be much more congested. Details on equipment and supplies for evacuees (including food, water, medicine, and fuel) are discussed later in this chapter.

134. *Time Requirements for Evacuation.* Soviet sources call for evacuation of Soviet cities within the "special period" (a period of warning) preceding an attack, and imply that the evacuation time would be about 72 hours. Soviet authorities have not published their assessment of actual time which would be required for evacuation of the nonessential population. Several US studies have addressed the speed with which the Soviets could complete their evacuation actions. A 1969 RAND study estimated that 100 million urban residents [27] could be evacuated in four days under optimum conditions, using only half of the available 1970 transportation capacity. A 1976 Defense Intelligence Agency study of the evacuation of 12 selected Soviet cities concluded that, under the most favorable conditions, the Soviets have a physical capability to evacuate most of the 12 cities within three to four days after movement begins. The major assumptions used in the DIA study were:

— 70 percent of population evacuated, 30 percent dispersed;

— two shifts working in essential industries and services;

— a six-hour alert preceding actual movements (this period of alert has been tested in Soviet exercises); and

— no other complications, such as panic, severe disruption of transport systems, or adverse weather conditions.

Figures 18, 19, and 20 and Table V summarize the findings of the DIA dispersal and evacuation study.

[27] This number of urban inhabitants equals the total population of some 450 cities with populations of 50,000 or more and includes almost all major administrative, residential, communication, and transportation centers.

TABLE V

DIA-Estimated Time Required for Evacuation of Twelve Selected Soviet Cities

| City | Numbers evacuated (thousands) [1] | Maximum distance (km) | Maximum distance (nm) | Estimated time required after movement begins (hours) [2] | Modes of transport |
|---|---|---|---|---|---|
| Leningrad | 2,673 | [3] | | 117+ | mostly rail, some maritime |
| Kiev | 1,407 | 110 | 60 | 36 | rail and highway |
| Tashkent | 1,158 | 260 | 140 | 81 | rail |
| Gor'kiy | 914 | 315 | 170 | 75 | rail and highway |
| Odessa | 718 | [4] | | 58 | mostly rail, some maritime |
| Dnepropetrovsk | 684 | 185 | 100 | 57 | rail |
| Khabarovsk | 351 | 410 [5] | 220 [5] | 56 | rail |
| Orenburg | 288 | 185 | 100 | 47 | rail |
| Kishinev | 331 | 75 | 40 | 39 | rail and highway |
| Sevastopol' | 187 | 165 | 90 | 29 | highway |
| Angarsk | 164 | 410 [5] | 220 [5] | 42 | rail |
| Kirovabad | 141 | 95 | 50 | 25 | rail |

[1] Represents 70 percent of city's inhabitants.

[2] Movement begins six hours after the alert. Methodology utilized in calculating evacuation times considers variables such as running speeds, loading and unloading rates, and sequences of unloading dictated by availability of facilities. Since these variables are not known quantities but judgments based on available evidence, the resulting figures for total evacuation time are approximate rather than exact values.

[3] Leningrad can accommodate some 90 large oceangoing ships which could offload evacuees at various ports along the Baltic coast, but a cycle time of three to four days is estimated before ships can return for more evacuees.

[4] Odessa, which can handle some 38 oceangoing ships, could offload evacuees in Romania and Bulgaria, but the cycle time for return of ships is four or more days.

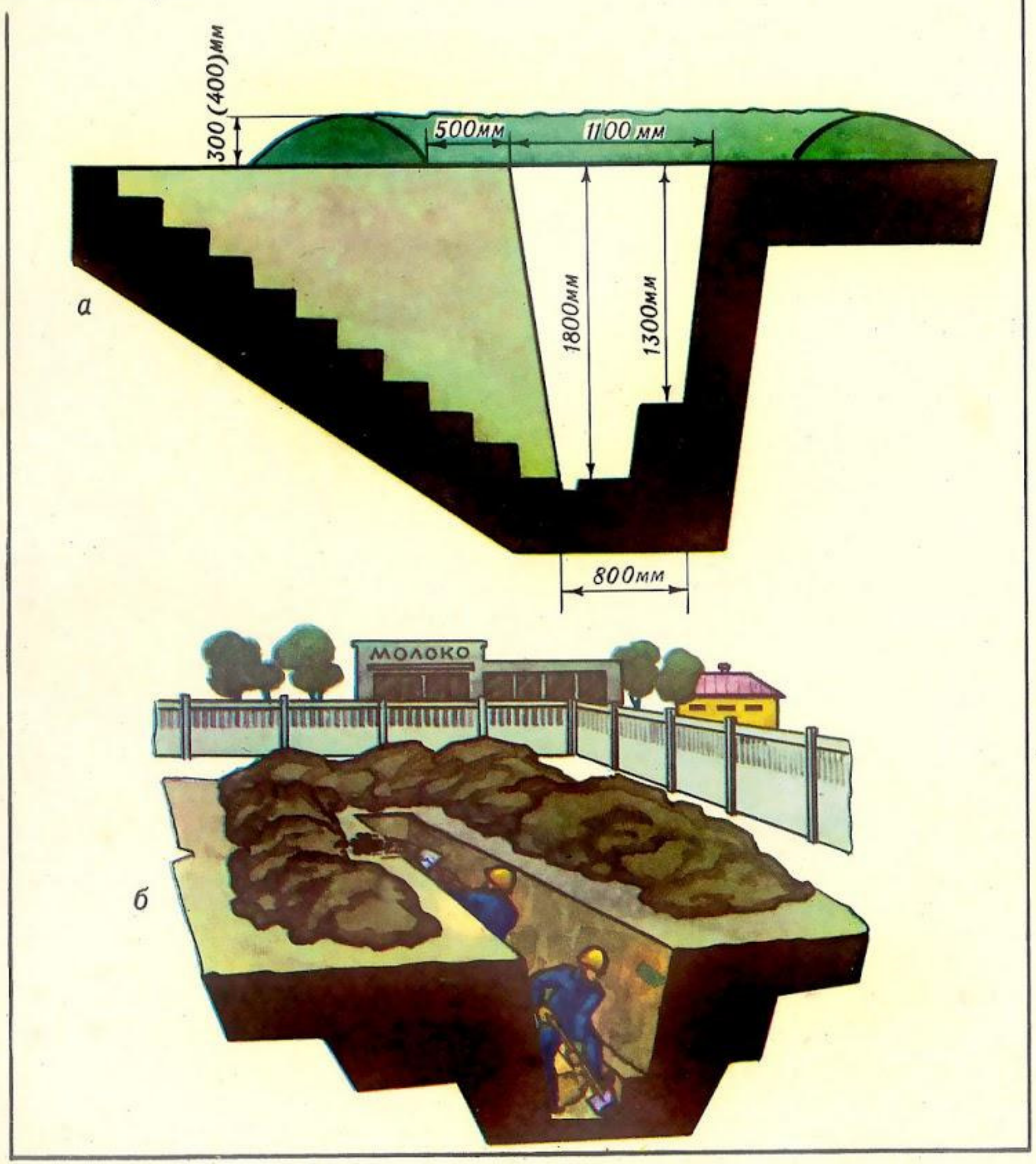
[5] Distances for Khabarovsk and Angarsk are greater than for larger cities because of low population density in surrounding areas.

# КОЛЛЕКТИВНЫЕ СРЕДСТВА ЗАЩИТЫ. ПРОСТЕЙШИЕ УКРЫТИЯ



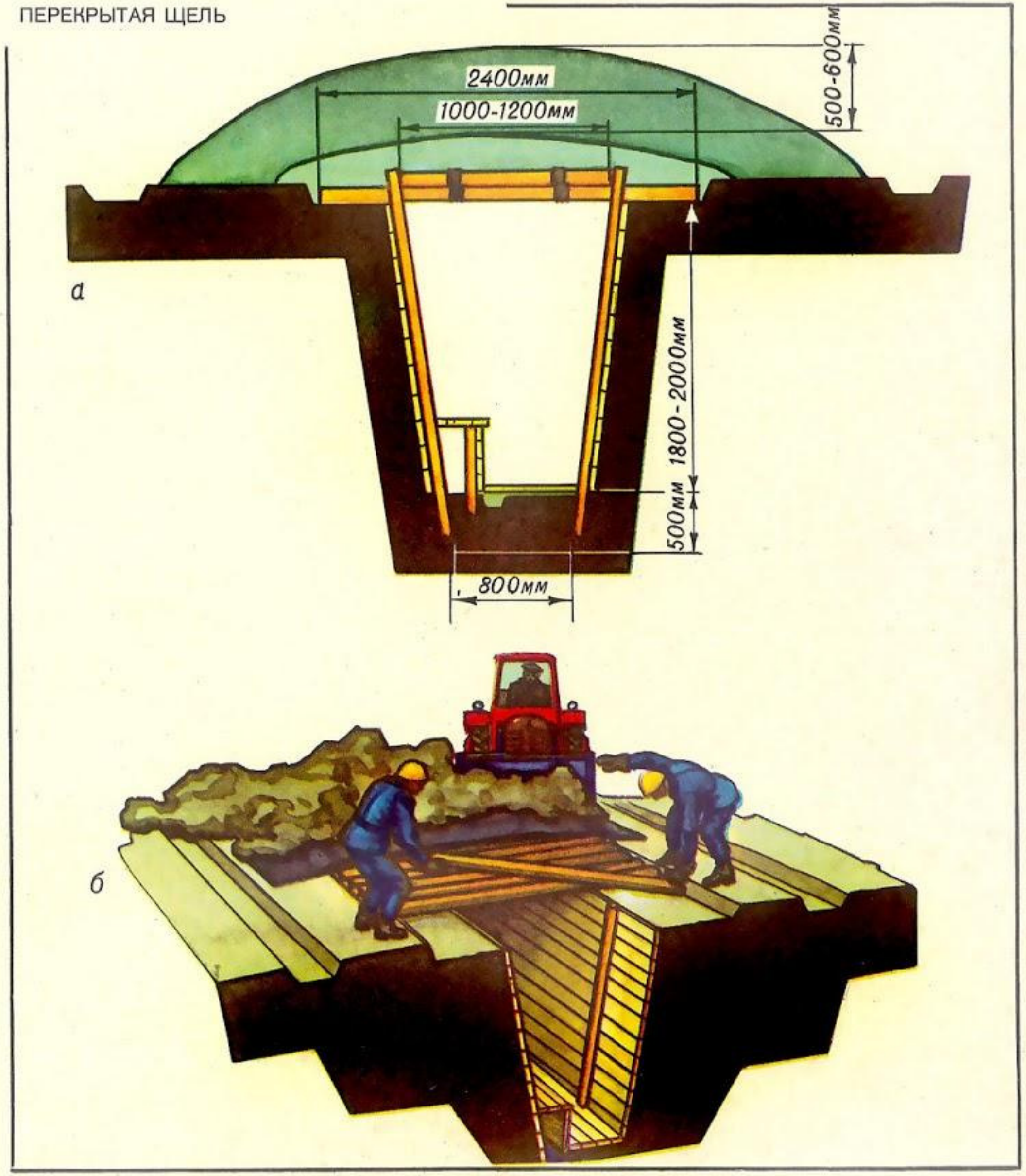
ПРОСТЕЙШИЕ УКРЫТИЯ ОСЛАБЛЯЮТ ВОЗДЕЙСТВИЕ УДАРНОЙ ВОЛНЫ И РАДИОАКТИВНОГО ИЗЛУЧЕНИЯ, ЗАЩИЩАЮТ ОТ СВЕТОВОГО ИЗЛУЧЕНИЯ И ОБЛОМКОВ РАЗРУШАЮЩИХСЯ ЗДАНИЙ, ПРЕДОХРАНЯЮТ ОТ ПОПАДАНИЯ НА ОДЕЖДУ И КОЖУ РАДИОАКТИВНЫХ, ОТРАВЛЯЮЩИХ И ЗАЖИГАТЕЛЬНЫХ ВЕЩЕСТВ

ОТКРЫТАЯ ЩЕЛЬ




а) схема щели; б) отрывка щели

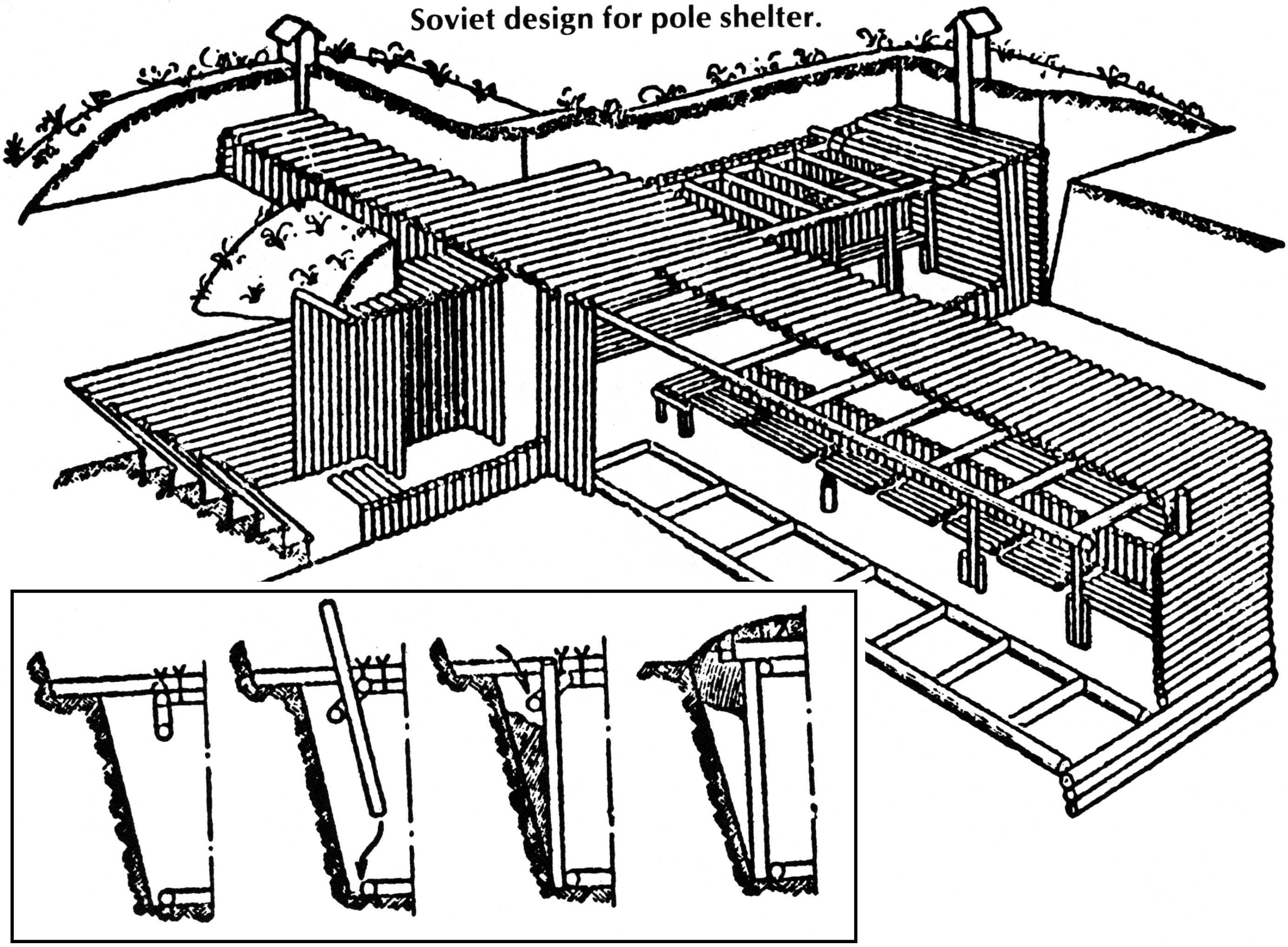
ПЕРЕКРЫТАЯ ЩЕЛЬ



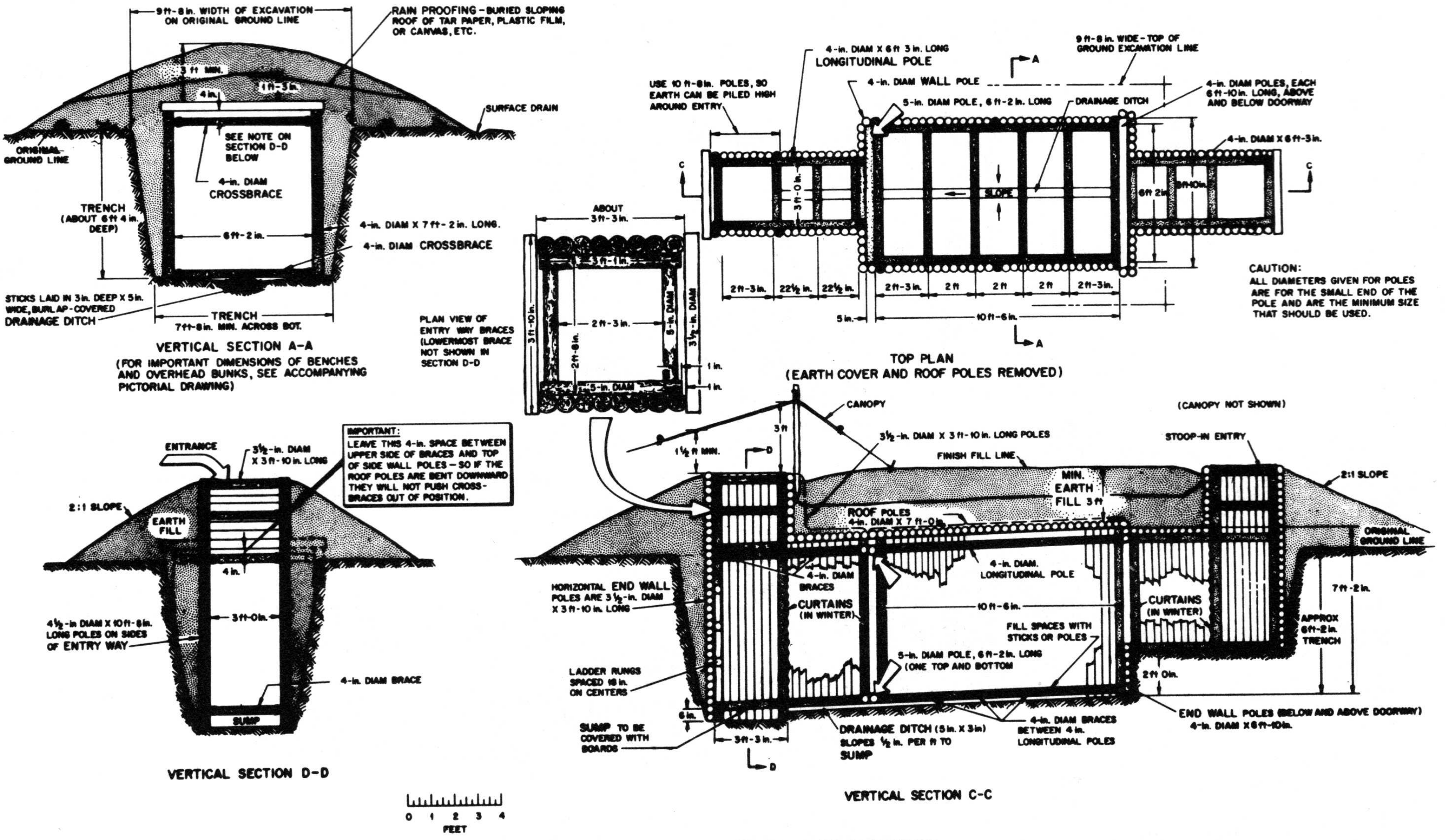

а) схема щели; б) сооружение перекрытой щели с одеждой крутостей

ПРИ УГРОЗЕ НАПАДЕНИЯ ПРОТИВНИКА НАСЕЛЕНИЕ МОЖЕТ СВОИМИ СИЛАМИ СООРУЖАТЬ ИЗ ПОДРУЧНЫХ МАТЕРИАЛОВ ПРОСТЕЙШИЕ УКРЫТИЯ ТИПА ОТКРЫТЫХ, ПЕРЕКРЫТЫХ ЩЕЛЕЙ И ДР.

## Soviet design for pole shelter.

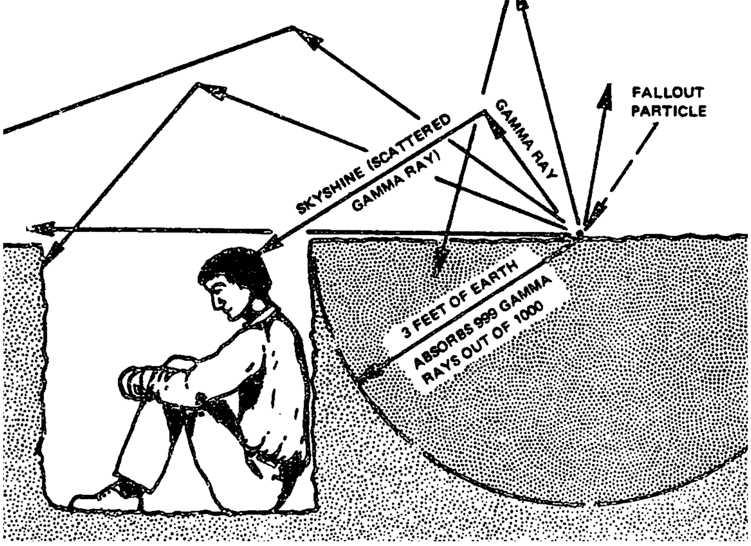


## Soviet design for pole shelter adapted for American use

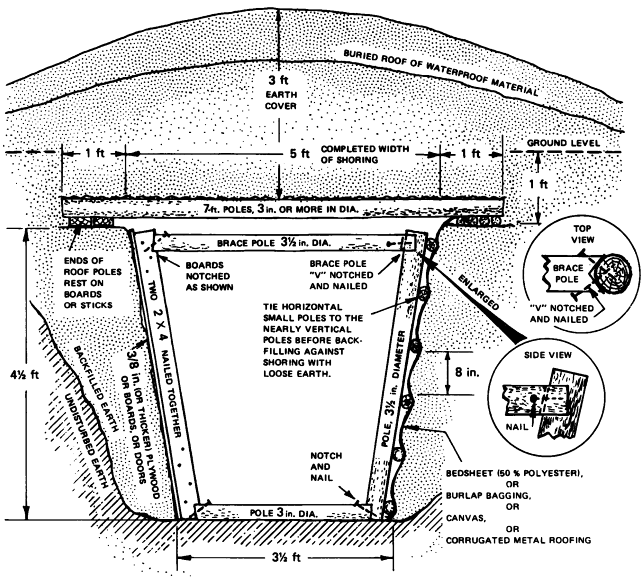



PLAN AND ELEVATION OF SMALL-POLE SHELTER.

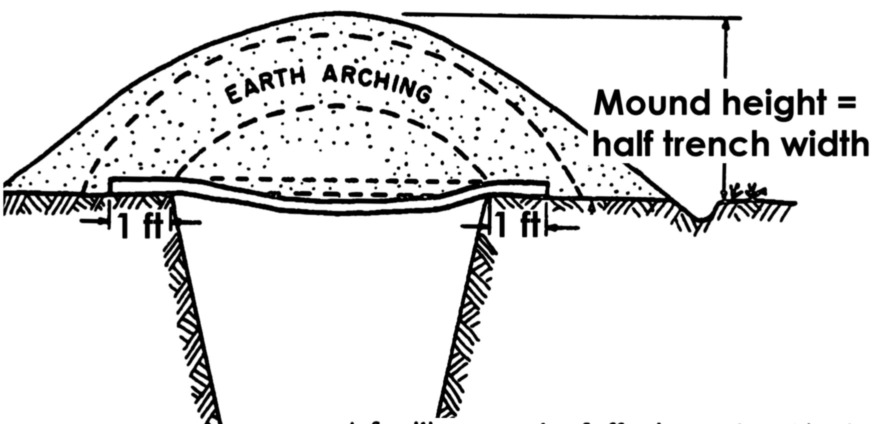
ORNL-5037



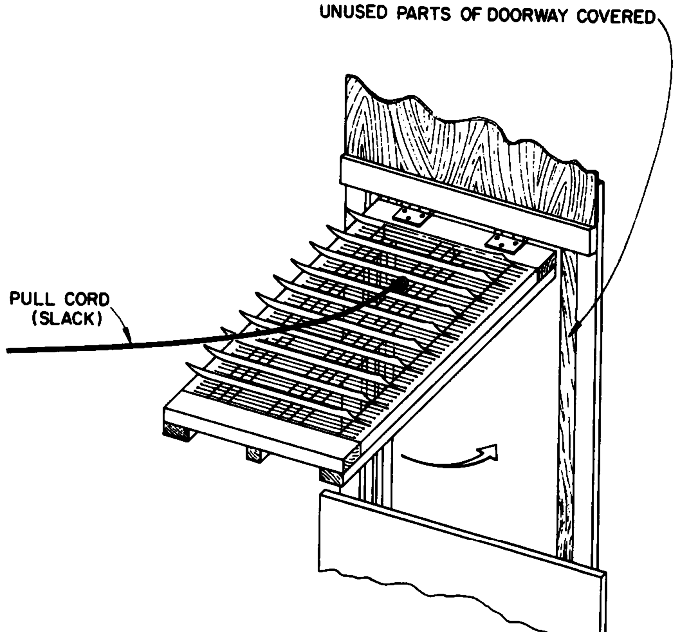

Methods for shoring a trench shelter.



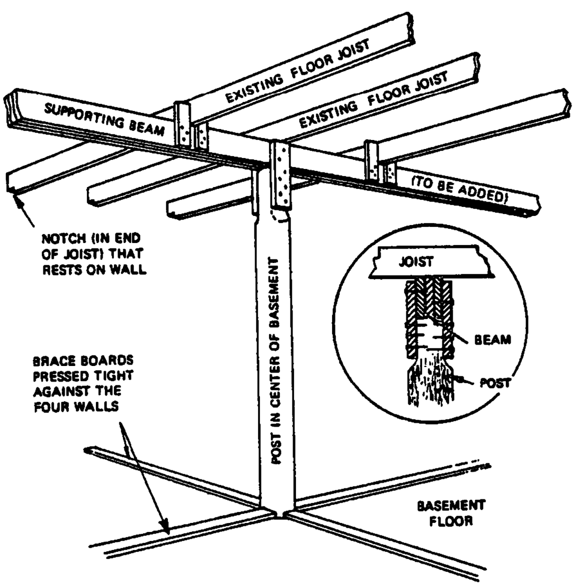

## EARTH ARCHING USED TO STRENGTHEN SHELTERS

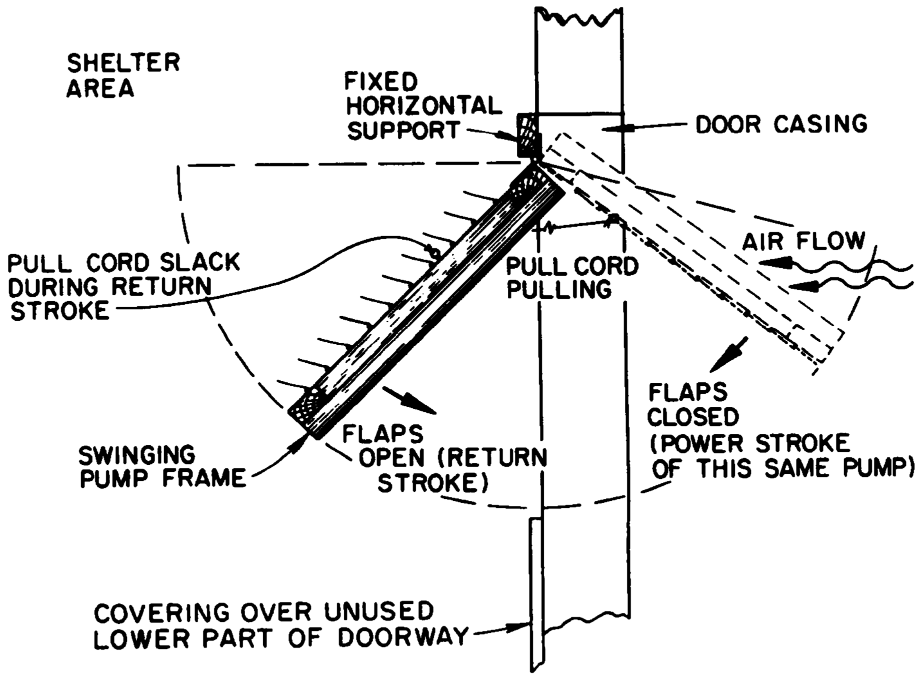



A familiar example of effective earth arching is its use with sheet metal culverts under roads. The arching in a few feet of earth over a thin-walled culvert prevents it from being crushed by the weight of heavy vehicles.



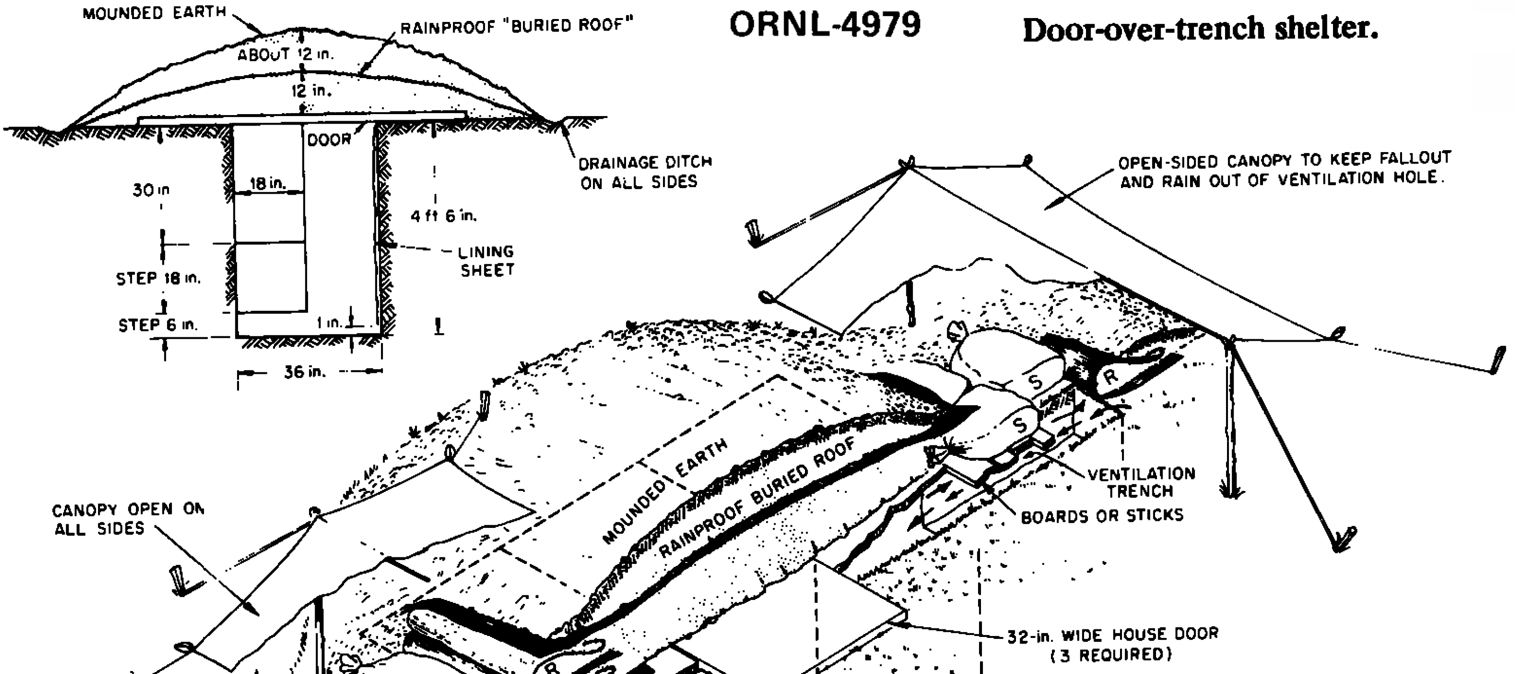

Kearny air pump.

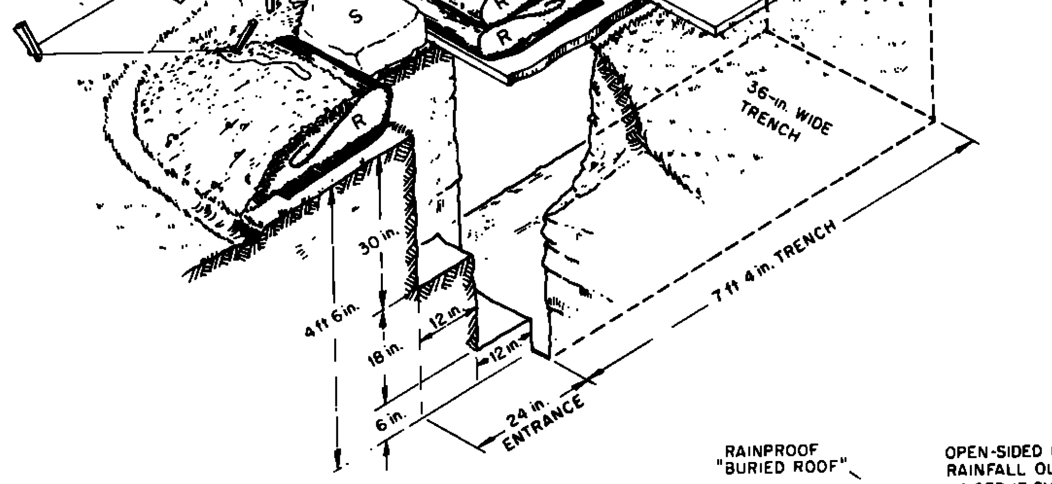


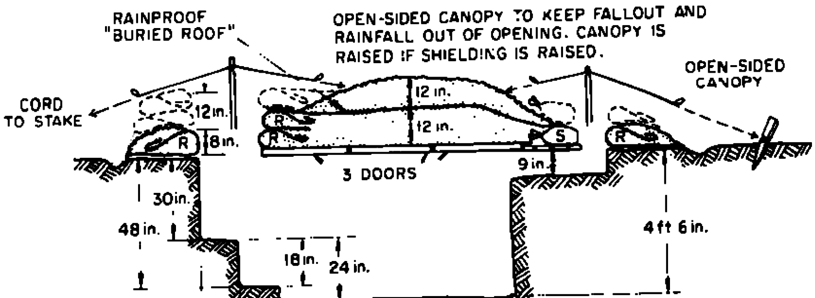



# ORNL-4979

**Door-over-trench shelter.**




# Survival of Food Crops and Livestock in the Event of Nuclear War

Proceedings of a symposium held at
Brookhaven National Laboratory
Upton, Long Island, New York
September 15–18, 1970

Sponsored by
Office of Civil Defense
U. S. Atomic Energy Commission
U. S. Department of Agriculture


Editors

**David W. Bensen**
Office of Civil Defense
**Arnold H. Sparrow**
Brookhaven National Laboratory



December 1971

**U. S. ATOMIC ENERGY COMMISSION Office of Information Services**

# THE SIGNIFICANCE OF LONG-LIVED NUCLIDES AFTER A NUCLEAR WAR

R. SCOTT RUSSELL, B. O. BARTLETT, and R. S. BRUCE
Agricultural Research Council, Letcombe Laboratory, Wantage, Berkshire, England

## ABSTRACT

The radiation doses from the long-lived nuclides $^{90}Sr$ and $^{137}Cs$, to which the surviving population might be exposed after a nuclear war, are considered using a new evaluation of the transfer of $^{90}Sr$ into food chains.

As an example, it is estimated that, in an area where the initial deposit of near-in fallout delivered 100 R/hr at 1 hr and there was subsequent worldwide fallout from 5000 Mt of fission, the dose commitment would be about 2 rads to the bone marrow of the population and 1 rad to the whole body. Worldwide fallout would be responsible for the major part of these doses.

It is now widely recognized that long-lived fission products would make a negligible contribution to the radiation exposure of the population in heavily contaminated areas shortly after a nuclear attack. The external radiation dose would usually be dominant, and, if simple precautions were taken to avoid the superficial contamination of foodstuffs, the entry of $^{131}I$ into milk would cause the only important problem of dietary contamination. Thus, for example, infants probably would not receive doses of more than 0.1 rad to bone marrow from $^{90}Sr$ nor more than 0.01 rad from $^{137}Cs$ in the weeks after a nuclear attack if they were fed continuously with milk produced in an area where the external dose rate at 1 hr after detonation had been 100 R/hr. Doses to the thyroid from $^{131}I$ might, however, exceed 200 rads.

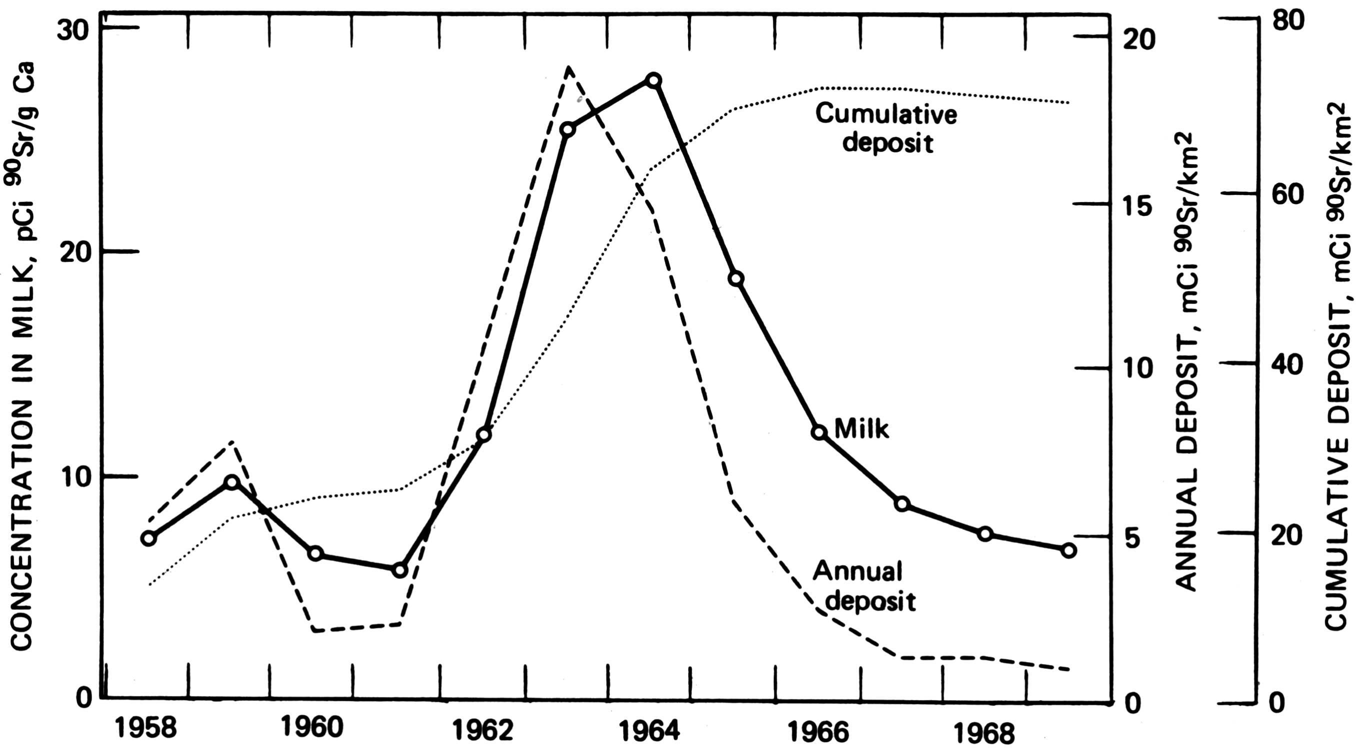



**Fig. 1** Strontium-90 in fallout and milk in the United Kingdom, 1958 to 1969.

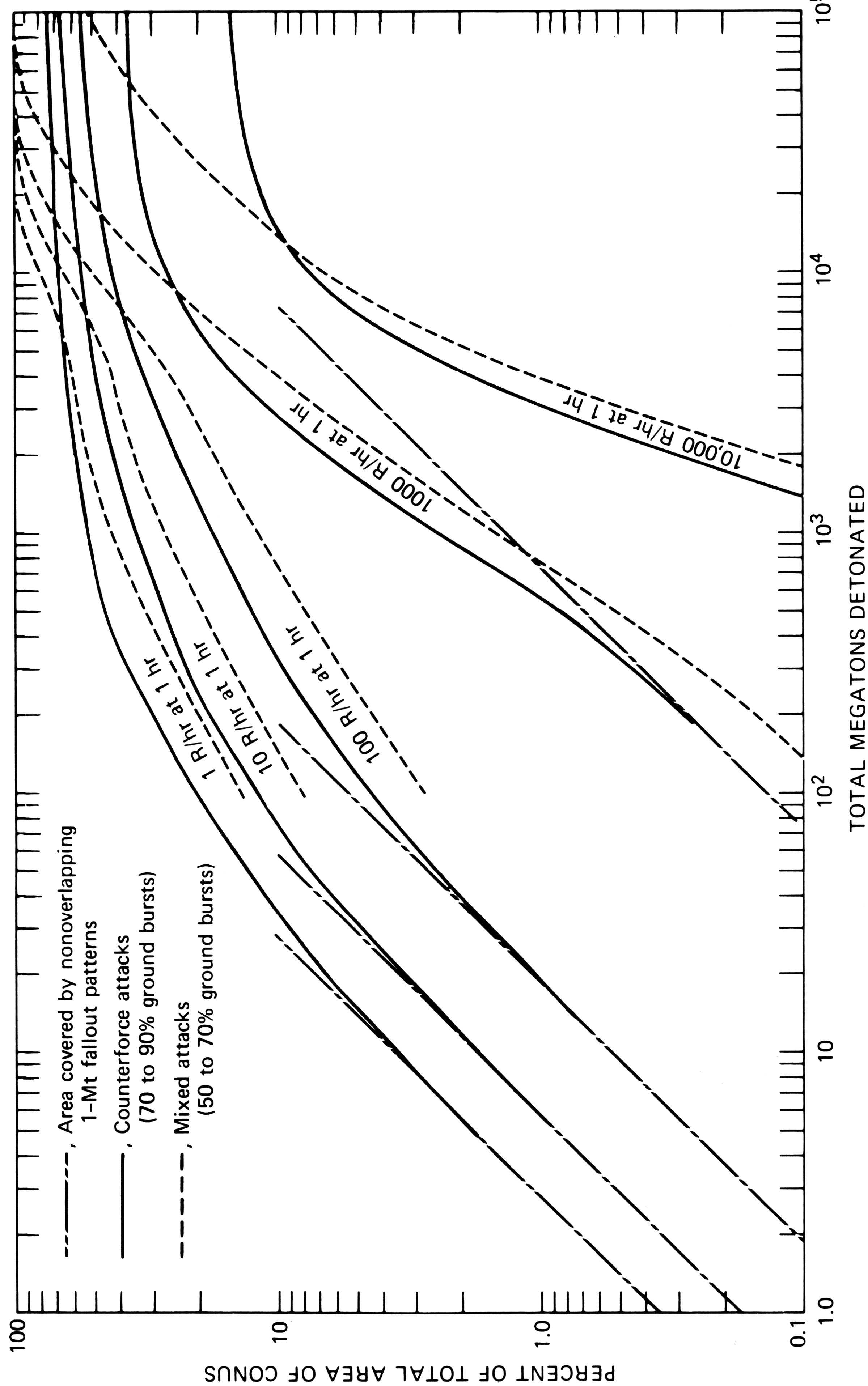
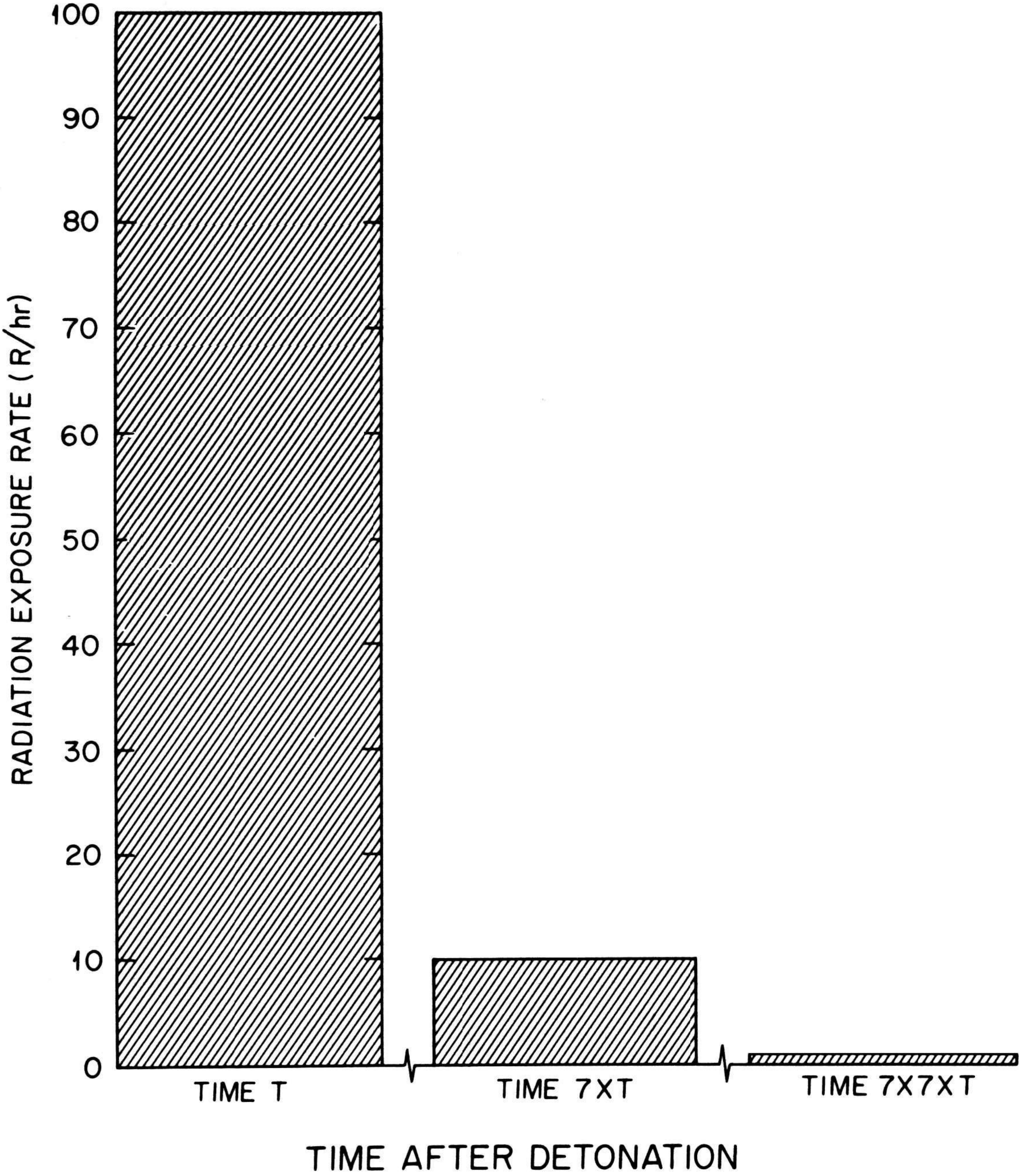
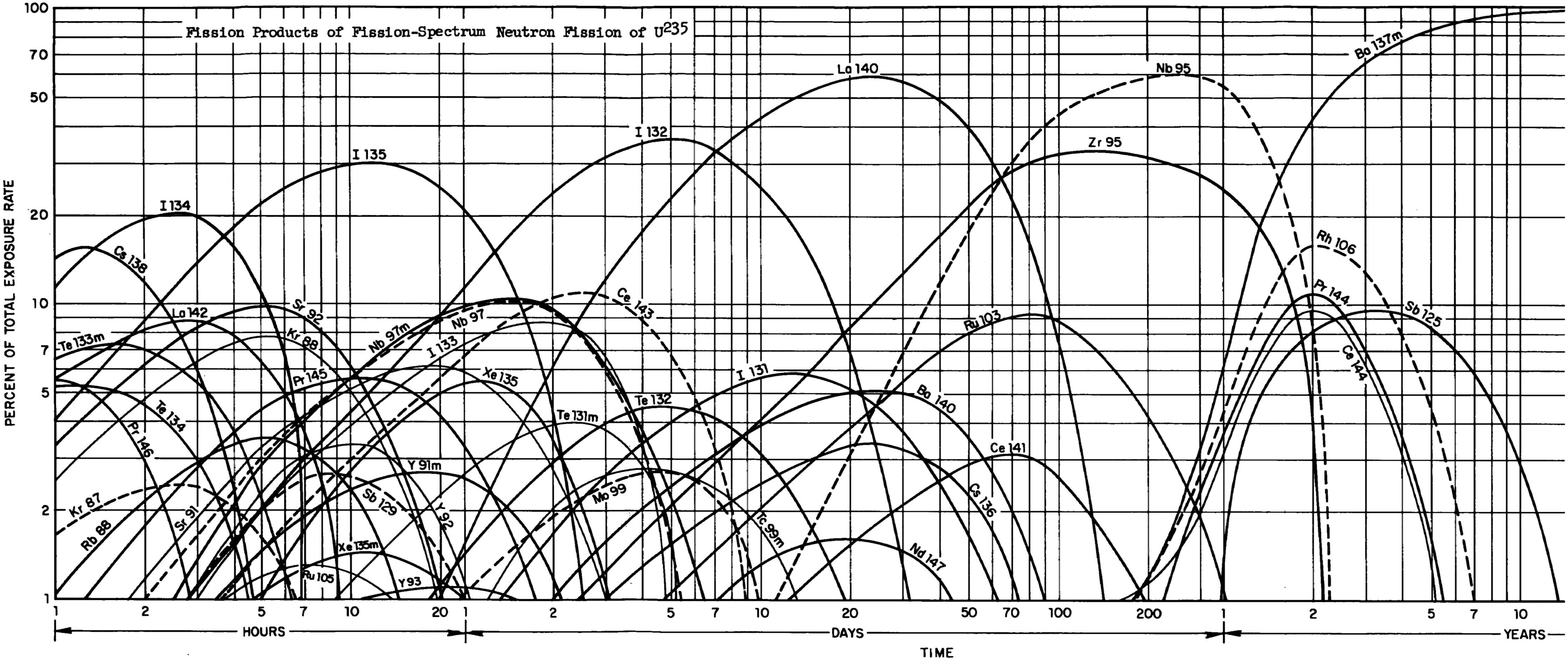



**Fig. 1** Percent of area of the continental United States enclosed within selected $I_s$ contours as a function of attack weight (50% fission weapons).

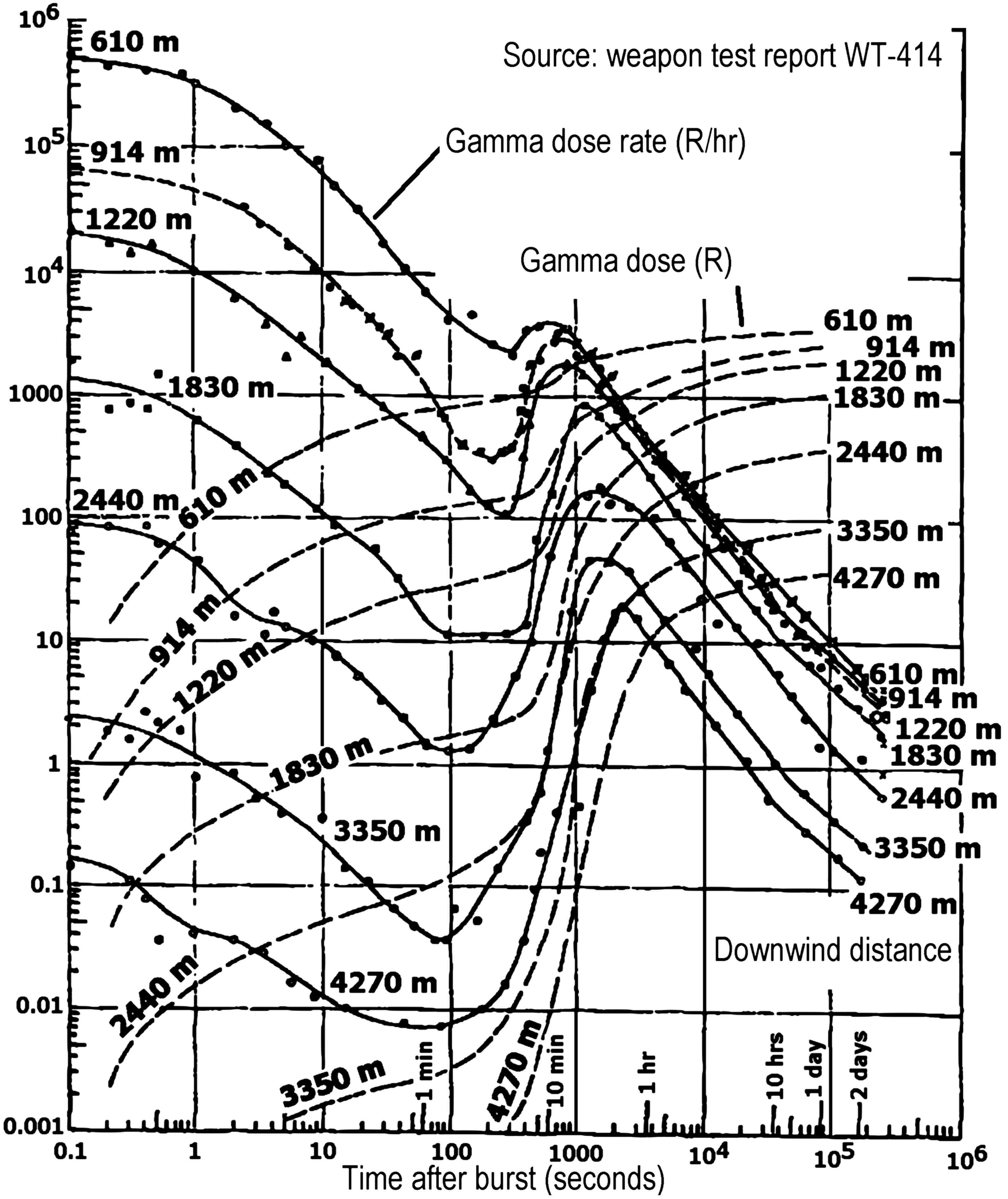


RADIATION EXPOSURE RATE (R/hr)
100
90
80
70
60
50
40
30
20
10
0
TIME T
TIME 7XT
TIME 7X7XT
TIME AFTER DETONATION

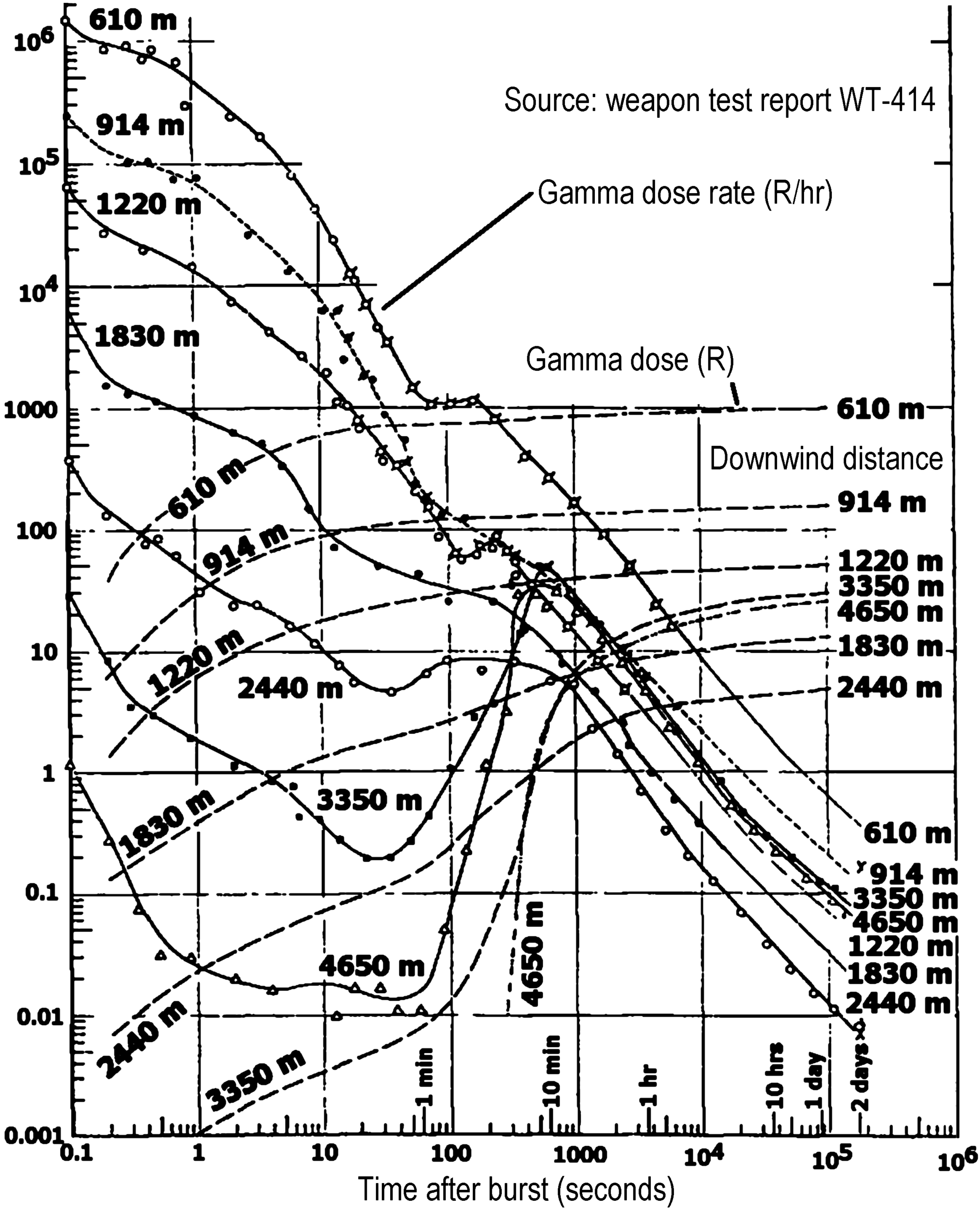
Source: USNRDL-TR-1009 (curves for Pu-239, U-233 and U-238 by different neutron energies are very similar)



## 1.2 kt UNCLE test (5.2 m underground, Nevada)



# 1.2 kt SUGAR test (Nevada surface burst)



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AD482985

# Operation JANGLE

## NEVADA PROVING GROUNDS
## OCTOBER-NOVEMBER 1951

Project 2.3-2

**FOXHOLE SHIELDING OF GAMMA RADIATION**

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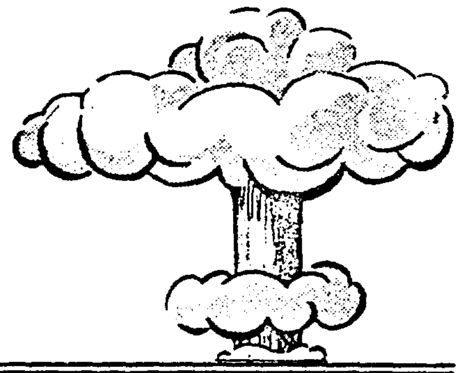

RESTRICTED DATA
ATOMIC ENERGY ACT 1946

ARMED FORCES SPECIAL WEAPONS PROJECT
WASHINGTON D.C.

UNCLASSIFIED

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Security Information

PROJECT 2.3-2

TABLE 3.1

Distribution of Gamma Radiation in Foxholes (Surface Burst)

| Range (ft) | Location | Two-man Foxhole | | | One-man Foxhole | | Soil Pipe |
|---|---|---|---|---|---|---|---|
| 2000 | 36" Above Surface | | 800 r | | | | |
| | Surface | | 700 | | | | |
| | 16" Below Surface | 230 | 205 | 415 | | | |
| | 32" Below Surface | 24 | 58 | 136 | | | |
| | 48" Below Surface | 12.8 | 22 | 62 | | | |
| 2500 | 36" Above Surface | | 230 r | | | | |
| | Surface | | 220 | | | | |
| | 16" Below Surface | 35 | 60 | 85 | | | |
| | 32" Below Surface | 7 | 15 | 26 | | | |
| | 48" Below Surface | 4 | 8.5 | 13.3 | | | |
| 3000 | 36" Above Surface | | 110 r | | | | 73 r |
| | Surface | | 90 | | | 55 | |
| | 16" Below Surface | 23 | 36 | 55 | 6.8 | 6.6 | 10 |
| | 32" Below Surface | 7.6 | 12.4 | 19.4 | 2.5 | 2.4 | 0.5 |
| | 48" Below Surface | 2.5 | 4.8 | 6.7 | 1.6 | 1 | 0 |
| 3500 | 36" Above Surface | | 41 r | | | | |
| | Surface | | --- | | | | |
| | 16" Below Surface | 3 | --- | 9.7 | | | |
| | 32" Below Surface | 1.6 | 2.8 | 3.4 | | | |
| | 48" Below Surface | .54 | .99 | 1.9 | | | |
| 4000 | 36" Above Surface | | 17 r | | | | 17 r |
| | Surface | | 9.6 | | | — | |
| | 16" Below Surface | 1.6 | 3 | 5.6 | — | 0.35 | — |
| | 32" Below Surface | 0.6 | 1.12 | 1.62 | — | — | 0.17 |
| | 48" Below Surface | — | 0.54 | 0.57 | 0.39 | — | — |
| 4500 | 36" Above Surface | | 9.8 r | | | | |
| | Surface | | 4.6 | | | | |
| | 16" Below Surface | 1 | 1.8 | 3.5 | | | |
| | 32" Below Surface | 0.5 | 0.7 | 1.04 | | | |
| | 48" Below Surface | 0.21 | 0.4 | 0.57 | | | |
| 5000 | 36" Above Surface | | 4.8 r | | | | |
| | Surface | | 2.7 | | | | |
| | 16" Below Surface | 0.6 | 0.99 | 2.95 | | | |
| | 32" Below Surface | 0.3 | 0.5 | 0.75 | | | |
| | 48" Below Surface | 0.17 | 0.2 | 0.38 | | | |

# CHAPTER 5

## CONCLUSIONS

### 5.1 FOXHOLE SHIELDING OF GAMMA RADIATION

#### 5.1.1 Surface Detonation

Standard foxholes provide excellent protection to personnel from the gamma radiation emitted during the detonation of an atomic weapon on the surface of the ground. The results from the comparatively small sized weapon employed in Operation JANGLE show that 2000 feet from the burst, the location of the closest foxhole doses of about 60r were measured at the bottom of a foxhole, less than 10 per cent of the dose measured 3 feet above the surface of the ground. Due to the location of the foxhole in the crosswind direction, the dose at the bottom was caused primarily by scattered prompt radiation plus a small contribution from the residual activity of the fission products on the surface of the ground. In the downwind direction there would be a contribution from matter that falls out from the cloud into the foxhole in addition to the above mentioned. This fall-out will depend on the wind velocity for a given sized weapon, and although it is expected to increase the dose in the foxholes, especially in those located close to the detonation, it is relatively unimportant in comparison to the prompt and residual activity since it can be easily shoveled out of the foxhole in a short time.

#### 5.1.2 Underground Detonation

With the possible exception of those located in the area close to the point of detonation where extensive fall-out occurs, foxholes also provide effective shielding in the case of an underground detonation. Even within this area of extensive fall-out, which at Operation JANGLE extended approximately 2000 feet, the high doses recorded in the foxholes could be greatly reduced by digging out the radioactive matter that fell into the hole. It is highly probable that one-half the doses recorded in the foxholes located within 2500 feet of the detonation at Operation JANGLE were directly attributable to this type of fall-out and most likely a higher percentage at distances greater than 2500 feet.

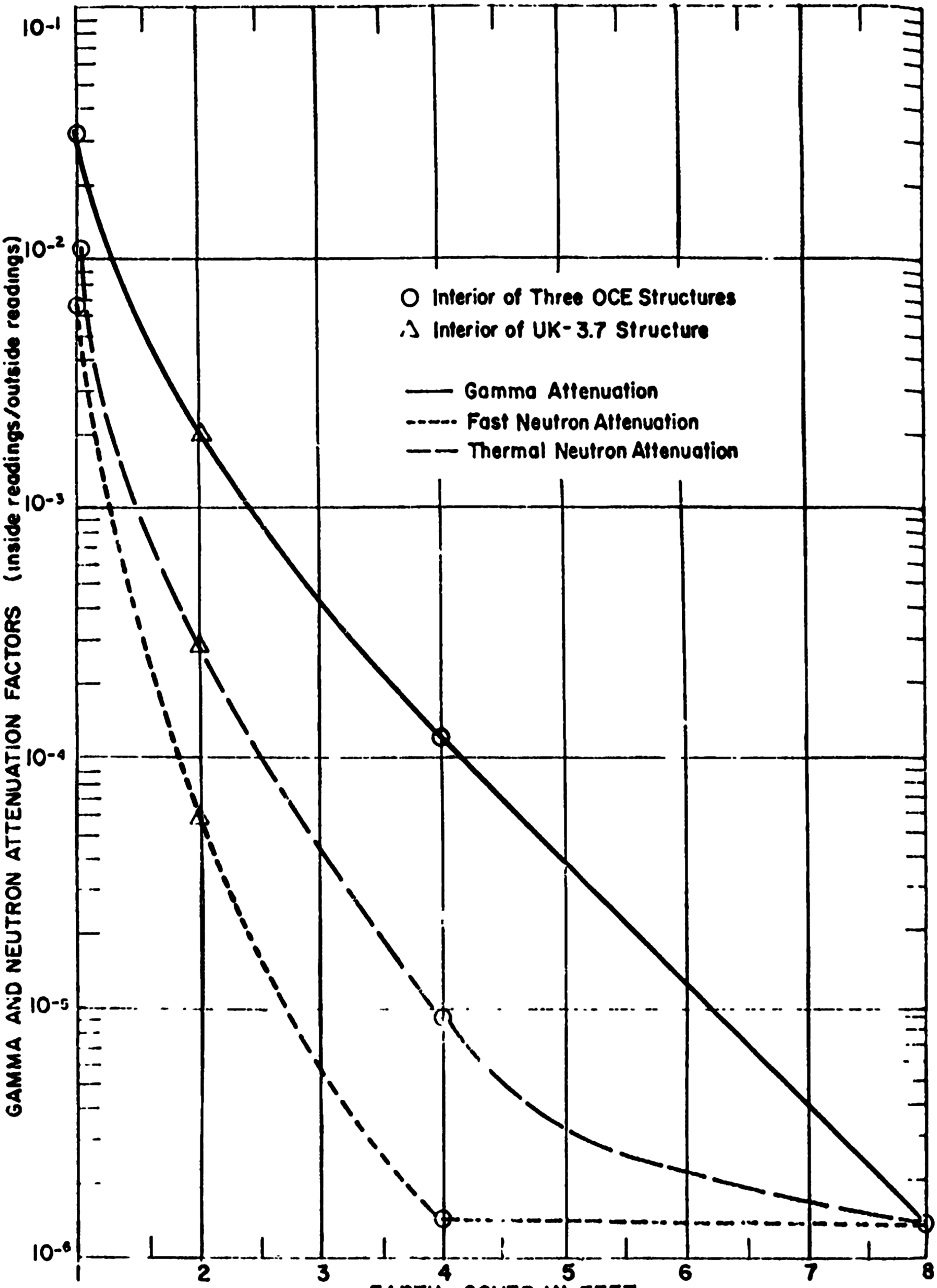



Figure 3.7 Gamma and neutron attenuation factors versus earth cover, Shot 12, 300 yards from ground zero. Outside gamma exposure, 307,000 r; outside thermal neutron flux, $6 \times 10^{13}$ n/cm$^2$, outside fast neutron flux, $1.3 \times 10^{13}$ n/cm$^2$.

ORNL-5037

# Nuclear War Survival Skills

Cresson H. Kearny

[Note: Kearny was inspired to write this by the USSR manuals like "Antiradiation shelters in Urban Areas", 1972, English translation: Oak Ridge Nat. Lab., ORNL-TR-2745.]

Oak Ridge National Laboratory
Oak Ridge, Tennessee

September 1979

# Summary

Underlying the advocacy of Americans' learning these down-to-earth survival skills is the belief that if one prepares for the worst, the worst is less likely to happen. Effective American civil defense preparations would reduce the probability of nuclear blackmail and war. Yet in our world of increasing dangers, it is significant that the United States spends much less per capita on civil defense than many other countries. The United States' annual funding is about 50 cents per capita, whereas Switzerland spends almost $11 and, most importantly, the Soviet Union spends approximately $20.

In the first chapter the myths and facts about the consequences of a massive nuclear attack are discussed. As devastating as such an attack would be, with adequate civil defense preparations and timely warning much of the population could survive.

One appendix of the handbook gives detailed, field-tested instructions for building six types of earth-covered expedient fallout shelters, with criteria to guide the choice of which shelter to build. The design features of several types of expedient blast shelters are described in another appendix. Two others contain instructions for making an efficient shelter-ventilating pump and a homemade fallout meter that is accurate and dependable. Both of these essentials can be made with inexpensive materials found in most households. Drawings are used extensively, as are photographs of people actually building and living in the various shelters.

This first-of-its-kind report is primarily a compilation and summary of civil defense measures and inventions developed at ORNL over the past 14 years and field-tested in six states, from Florida to Utah.

- **Myth:** Fallout radiation from a nuclear war would poison the air and all parts of the environment. It would kill everyone. (This is the demoralizing message of *On the Beach* and many similar pseudo-scientific books and articles.)
- **Myth:** A heavy nuclear attack would set practically everything on fire, causing "firestorms"
- **Myth:** In the worst-hit parts of Hiroshima and Nagasaki where all buildings were demolished, everyone was killed by blast, radiation, or fire.
- **Myth:** Because some modern H-bombs are over 1000 times as powerful as the A-bomb that destroyed most of Hiroshima, these H-bombs are 1000 times as deadly and destructive.

These exaggerations have become demoralizing myths, believed by millions of Americans.

HIROSHIMA. Typical, part below ground, earth-covered, timber framed shelter 300 yds. from the centre of damage

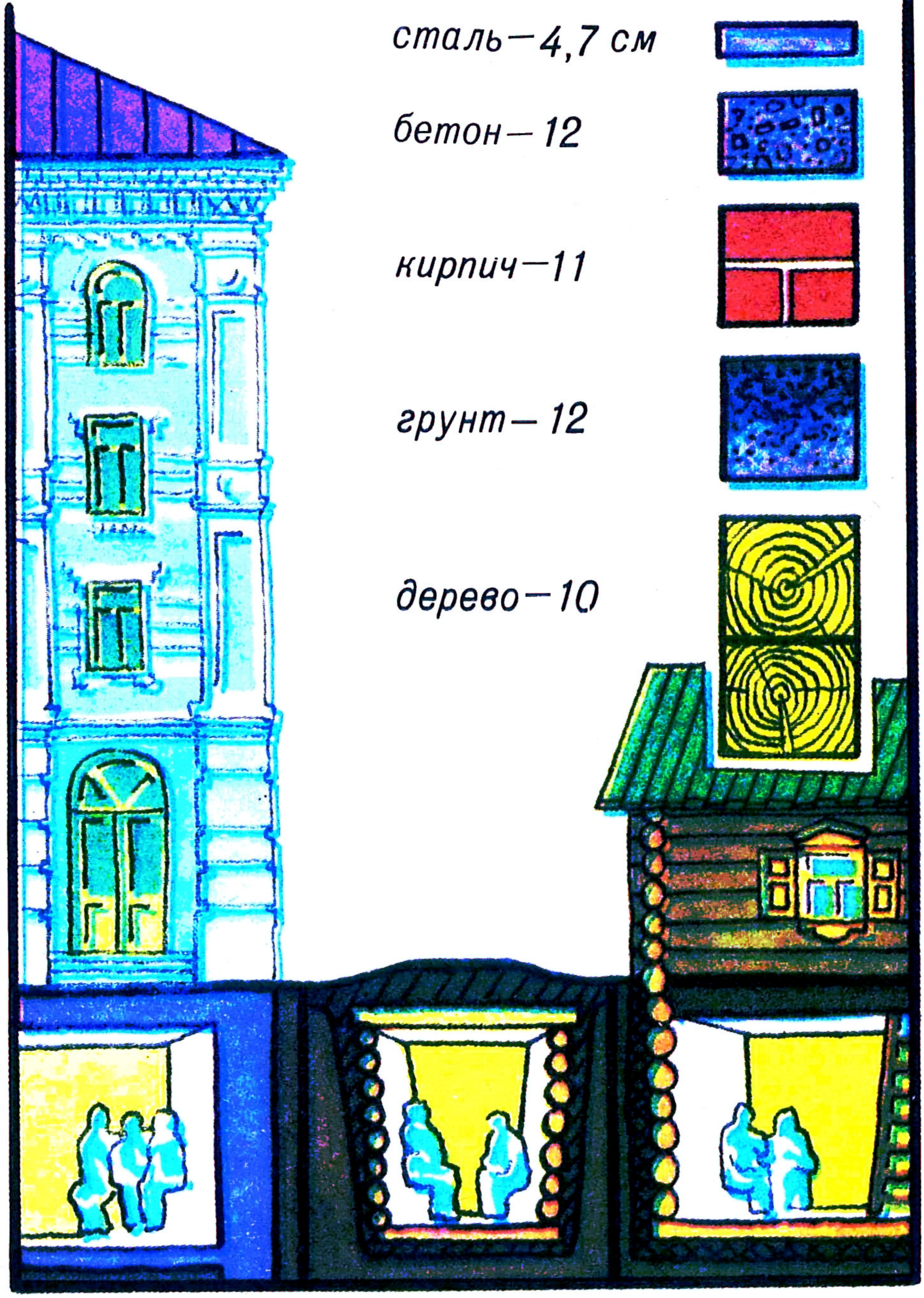
NAGASAKI. Typical small earth-covered back yard shelter with crude wooden frame, less than 100 yds. from the centre of damage

## PREVENTION OF THYROID DAMAGE FROM RADIOACTIVE IODINES

An extremely small and inexpensive daily dose of the preferred non-radioactive potassium salt, potassium iodide (KI), if taken 1/2 hour to 1 day before exposure to radioactive iodine, will reduce later absorption of radioactive iodine by the thyroid to only about 1% of what the absorption would be without this preventive measure. Extensive experimentation and study have led to the Federal Drug Administration's approval of 130-milligram (130-mg) tablets for this preventive (prophylactic) use only. A 130-mg dose provides the same daily amount of iodine as does each tablet that English authorities for years have placed in the hands of the police near nuclear power plants, for distribution to the surrounding population in the very unlikely event of a major nuclear accident. It is quite likely that a similar-sized dose is in the Russian "individual, standard first-aid packet." According to a comprehensive Soviet 1969 civil defense handbook, this first-aid packet contains "anti-radiation tablets and anti-vomiting tablets (potassium iodide and etaperain)."

# ЗАЩИТНЫЕ СВОЙСТВА МАТЕРИАЛОВ

**Экспозиционную дозу радиации ослабляют вдвое материалы толщиной**



READ GAP FROM 12 INCHES OVER TOP

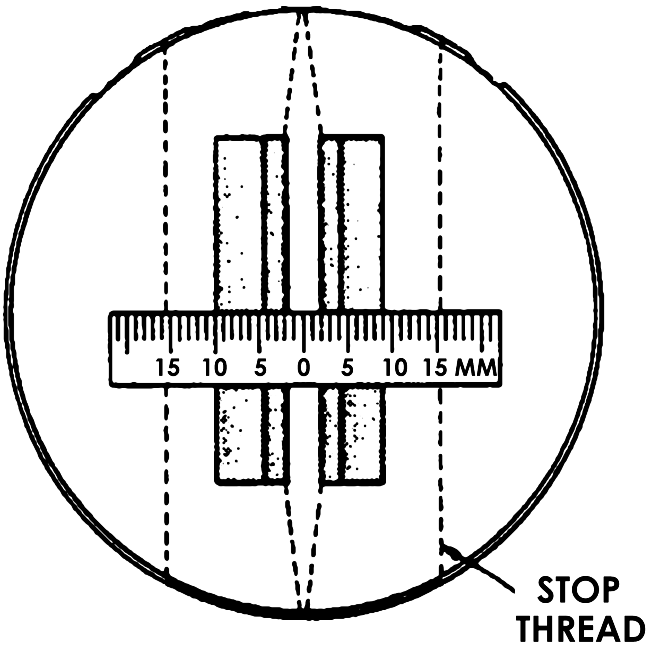
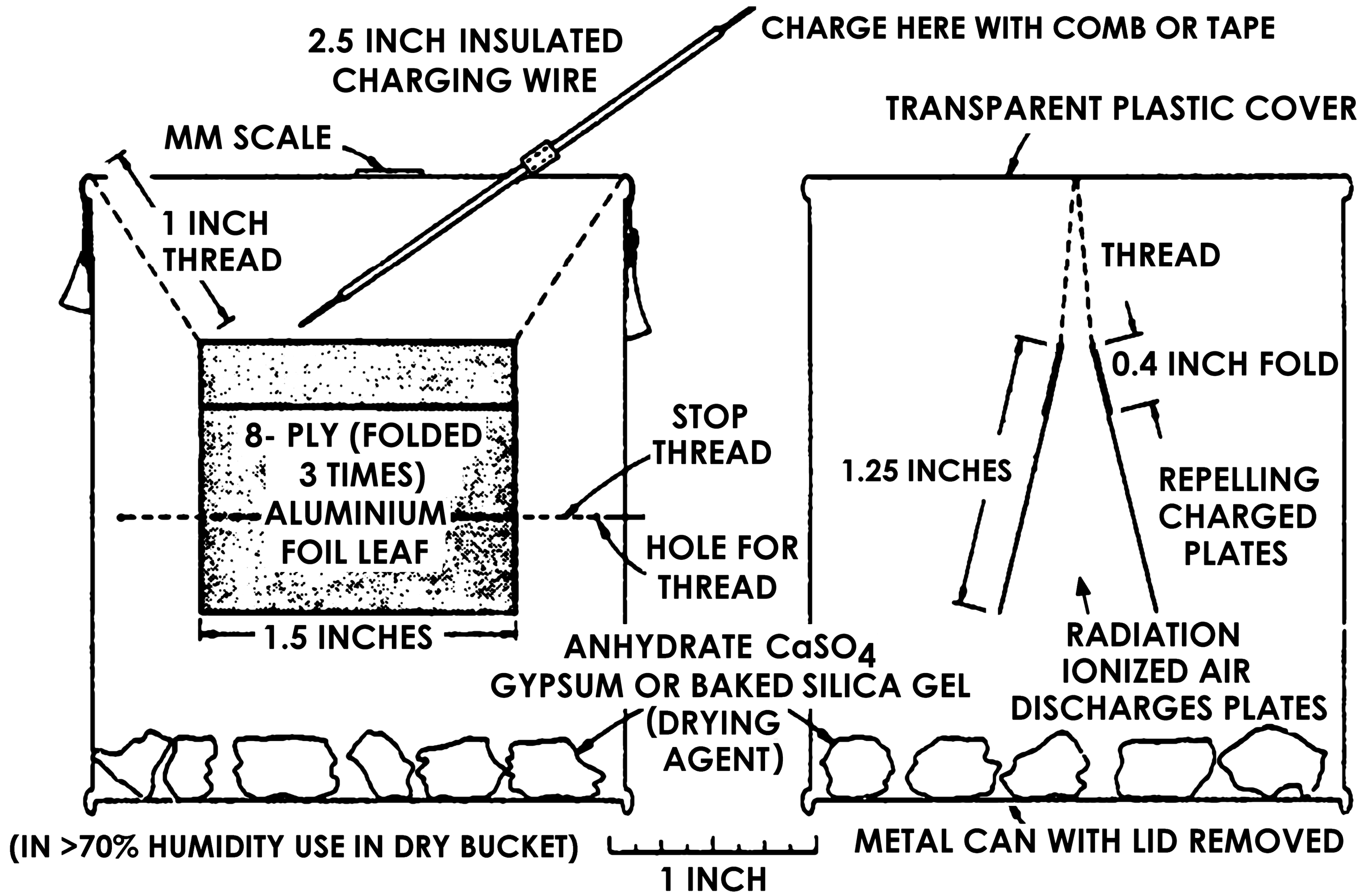


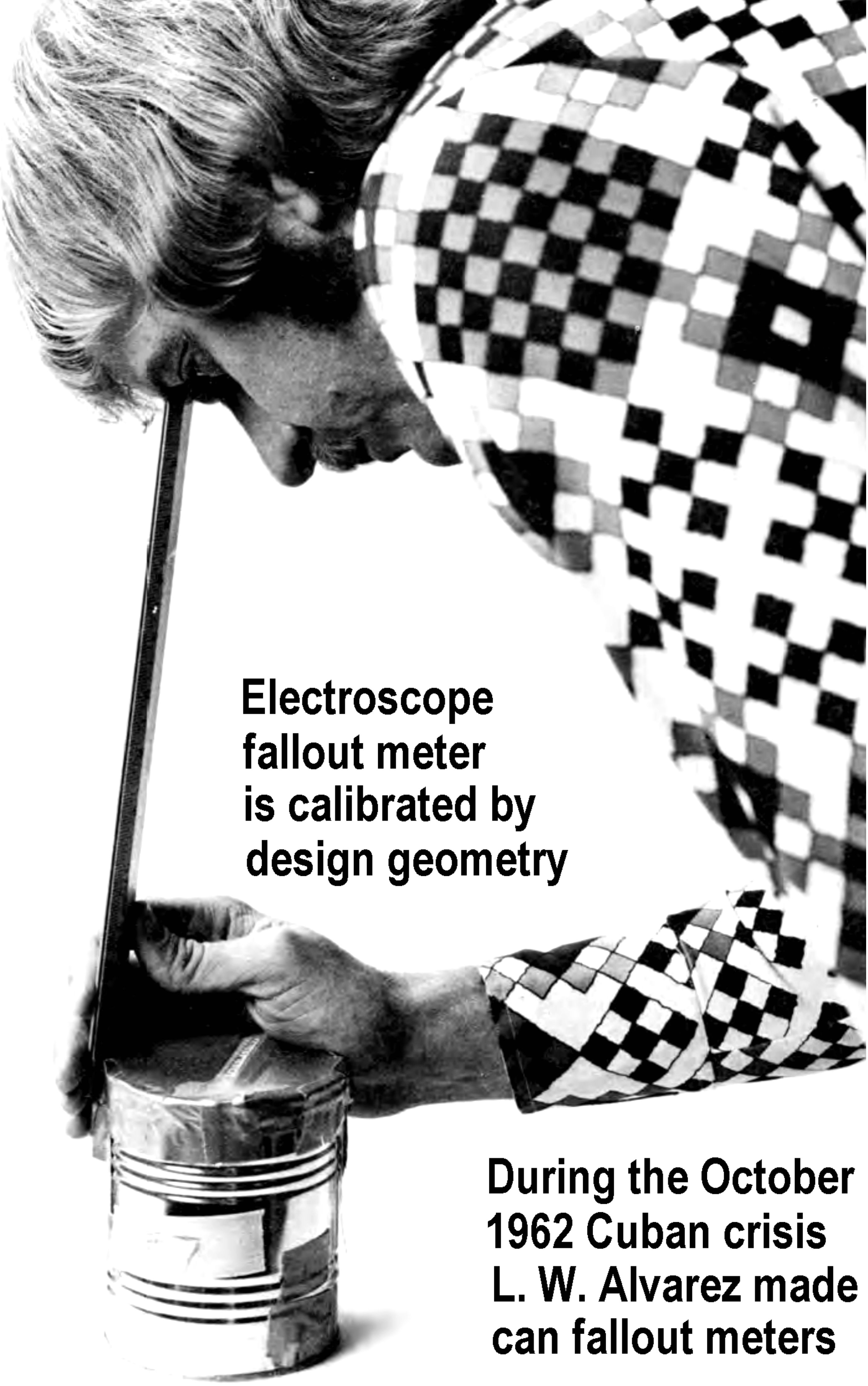

**TABLE USED TO FIND DOSE RATES (R/HR)**

**Reading in mm is difference in gap between aluminium leaves, before and after exposure**

| | TIME INTERVAL OF RADIATION EXPOSURE | | | | |
|---|---|---|---|---|---|
| | 15 SEC | 1 MIN | 4 MIN | 16 MIN | 1 HR |
| Reading | R/HR | R/HR | R/HR | R/HR | R/HR |
| 2 MM | 6.2 | 1.6 | 0.4 | 0.1 | 0.03 |
| 4 MM | 12 | 3.1 | 0.8 | 0.2 | 0.06 |
| 6 MM | 19 | 4.6 | 1.2 | 0.3 | 0.08 |
| 8 MM | 25 | 6.2 | 1.6 | 0.4 | 0.10 |
| 10 MM | 31 | 7.7 | 2.0 | 0.5 | 0.13 |
| 12 MM | 37 | 9.2 | 2.3 | 0.6 | 0.15 |
| 14 MM | 43 | 11 | 2.7 | 0.7 | 0.18 |

Thread for suspending aluminium foil plates must be an insulator (not conductor). Most thread is anti-static (conducting) and no use. Clean human hair, dental floss, or fishing line can be used. Alternatively, thin (about 3 mm wide) strips of flexible plastic from plastic bags can be used.




Electroscope
fallout meter
is calibrated by
design geometry
During the October
1962 Cuban crisis
L. W. Alvarez made
can fallout meters

86th Congress }
1st Session }
JOINT COMMITTEE PRINT

# BIOLOGICAL AND ENVIRONMENTAL EFFECTS OF NUCLEAR WAR

## SUMMARY-ANALYSIS OF HEARINGS

JUNE 22–26, 1959

## JOINT COMMITTEE ON ATOMIC ENERGY

CONGRESS OF THE UNITED STATES

AUGUST 1959

Printed for the use of the Joint Committee on Atomic Energy

UNITED STATES
GOVERNMENT PRINTING OFFICE
44501° WASHINGTON : 1959

# CONTENTS

## ERRATUM

On page 8, beginning at the 12th line from the bottom, the paragraph should read:

"Probably the most significant finding presented to the subcommittee was that civil defense preparedness could reduce the fatalities of the assumed attack on the United States from approximately 25 percent of the population to about 3 percent. The provision of shielding against radiation effects would at the same time protect against blast and thermal effects for the vast majority of the population."

44501°—59

The resources of the Atomic Energy Commission, its personnel and unclassified publications, were made available by Chairman McCone and were of great value to the subcommittee.

The subcommittee also utilized a mass of unclassified data furnished by other governmental and private sources on the effects of radiation. A special mention of appreciation is due Dr. Paul Tompkins and his associates of the U.S. Naval Radiological Defense Laboratory. Much of the basic data presented at the hearings was derived from the work of the USNRDL, and Dr. Tompkins and his staff consulted freely with the subcommittee throughout the hearings and during the preparation of this report.

The witnesses presenting testimony were selected on the basis of their competence and experience in the different fields of nuclear phenomena, with particular emphasis on nuclear weapons effects.

In the biomedical field the subcommittee received testimony from those scientists and technical personnel having the broadest experience in laboratory work on test animals and in the treatment of human beings exposed to radiation at Hiroshima and Nagasaki and in the accidental contamination of the Marshall Islands.

For the consideration of structural damage from blast and fire and of other weapons effects, outstanding authorities presented their findings and the latest available scientific data.

The weather patterns and other meteorological data for the date of the hypothetical attack were established by experts of the U.S. Weather Bureau, supported by their worldwide organization.

The reader is encouraged to examine the full testimony and supporting data of each witness in the printed record of the hearings. In this report the subcommittee has endeavored to present a faithful and concise summary of the data and to highlight the key issues for the convenience of the public and the Congress. Naturally, these data and issues are more completely set forth in the verbatim hearing record.

## II. Summary

### THE HYPOTHETICAL ATTACK

The hypothetical attack set forth by the subcommittee assumed that 263 nuclear weapons in 1, 2, 3, 8, and 10 megaton sizes with a total yield of 1,446 megatons [5] were detonated on 224 targets within the United States. An additional 2,500 megatons were assumed to have been detonated elsewhere in the Northern Hemisphere in attacks on overseas U.S. bases and in retaliation against the aggressor homeland. All weapons were arbitrarily designated as having a yield of 50 percent fission and 50 percent fusion. A weapon with 50 percent fission yield is one in which 50 percent of the total energy (yield) is derived from the fission process. Nuclear fission refers to the splitting of heavy atoms such as uranium and is the primary source of contamination of radioactive fallout particles.

[5] A 1-megaton bomb has the same explosive energy release as 1 million tons of TNT. The Hiroshima bomb yield was estimated at 20,000 tons of TNT, or 20 kilotons.

## CASUALTIES AND DAMAGE TO DWELLINGS

The expert testimony and supporting scientific data presented at the subcommittee hearings indicate that under present conditions such an attack would have cost the lives of approximately 50 million Americans, with some 20 million others sustaining serious injuries. More than one-fourth (11.8 million) of the dwellings in the United States would have been destroyed and nearly 10 million others would have been damaged. Some 13 million additional homes would have been severely contaminated by radioactive fallout. Altogether, approximately 50 percent of existing dwellings in the United States would have been destroyed or rendered unuseable for a period of several months.

Although the weapon detonations used in this exercise were designated as surface bursts, which would maximize the local radioactive fallout hazard, nearly 75 percent of the deaths would have resulted from the blast and thermal effects, combined with immediate radiation effects. Only 25 percent of all fatalities would have resulted from fallout. At the same time, more than half of the surviving injured would have radiation injuries.

Most of the damage sustained by dwellings would have resulted from the blast and thermal effects.

## BIOLOGICAL EFFECTS

The three casualty-producing phenomena of nuclear weapons—blast, thermal, and radiation—occur in varying combinations, depending on proximity to the point of detonation. At close range one would encounter all three, including fallout radiation as well as immediate radiation from the fireball.

### 1. *Blast effects*

Blast produces primary effects resulting from the blast wave itself (lung damage, rupture of eardrums); secondary effects, resulting from flying fragments (loose debris, building materials) propelled with great force by the blast wave; and tertiary effects, resulting from the body itself being thrown violently by the blast wave. In addition, miscellaneous injuries will result from conditions created by the blast on surrounding objects (e.g., broken gas mains, downed power lines).

Approximately 95 percent of the blast casualties produced by a 10-megaton weapon will result from the secondary and tertiary blast effects. For this size weapon the secondary effects are important to a distance of 11 miles; the tertiary effects can occur to distances of from 7 to 16 miles.

### 2. *Thermal effects*

Thermal effects consist of fires caused by direct ignition of combustible materials, skin burns on exposed portions of the body, and temporary or permanent blindness from the intense light of the fireball.

In the hypothetical attack situation posed by the subcommittee, thermal effects, including the hazard of mass fires ("fire storms"), could extend over large areas, in some cases up to distances of 20 to 25 miles from the point of detonation.

*3. Radiation effects*

The most severe form of radiation injury, under conditions of nuclear war, would be that resulting from severe exposure to the primary radiation "flash" (close to ground zero) or that attending whole body exposure to close-in fallout during the first day or so. However, severe irradiation could occur as a result of prolonged exposure to local fallout even after the first day unless survivors were provided with adequate shelter protection. Direct contamination of the skin with fallout debris could produce painful "beta burns" due to the action of beta rays irradiating the skin and outer layers of the body surface. In addition, there is an internal hazard of radioactive material which gains entry into the body through inhalation, ingestion, or through open wounds.

(1) *Acute effects.*—Instantaneous radiation doses of 5,000 roentgens or greater immediately produce symptoms of shock; death occurs within hours.

Radiation doses of 1,000 to 5,000 roentgens produce nausea and vomiting, fever and general fatigue within a few hours. Temporary recovery is followed within 1 or 2 weeks by reappearance of symptoms and probable death.

Exposure to doses of 200 to 1,000 roentgens causes nausea and vomiting within a few hours and in the period of from 2 to 4 weeks after exposure major changes will occur in the composition of the blood, rendering the body particularly susceptible to infections during this time. Approximately one-half of those exposed at the level of 450 to 700 roentgens would be expected to recover if not subjected to additional physical stress or radiation. The other one-half would die within 2 to 4 months. Probability of recovery increases greatly at levels below 450 roentgens.

Radiation doses of 200 roentgens or less will produce only mild symptoms of nausea and vomiting. Changes in the blood may occur later, but individuals so exposed usually will not require hospitalization.

(2) *Effects of protracted radiation.*—Higher radiation doses can be tolerated by the body without developing symptoms of acute radiation illness if exposure is spread over a longer period of time. Approximately 90 percent biological recovery can occur with continued or repeated exposures, but the remaining 10 percent nonrepairable injury may produce late effects, such as cancer, over a period 20 years or more.

When only a part of the body is exposed, the ability to recover is greatly increased. For example, the exposure of a person's legs alone to 500 roentgens of radiation would not result in a lethal dose.

The probability of increasing the incidence of leukemia and other types of cancer is considered proportional to the average total radiation dose sustained by the surviving population. Potential deaths from this cause are estimated as about 2 percent of the deaths attributable to acute radiation injury. These deaths will be spread out over a period of decades since it is a characteristic of radiation-induced cancer to be long delayed after incidence of injury.

(3) *Skin burns from fallout.*—Skin burns can be caused by beta rays from the fallout particles coming in direct contact with the skin. However, very large doses of beta radiation are required to produce severe burns, and the particles may be removed from the skin by good

fallout decontamination would be required to reduce the strontium 90 content of the soil to a level acceptable for production of some food crops and milk.

*3. Long-term environmental effects*

Although much remains to be learned about the long-range impact of a nuclear war on "the balance of nature," the concensus of the testimony was that, despite the severe shock, life would continue and full ecological recovery would eventually occur.

## ADDITIONAL DATA ON RADIOACTIVE FALLOUT

Several additional factors presented to the subcommittee with respect to radioactive fallout are considered highly important.

(1) The worldwide strontium 90 fallout resulting from the assumed attack would not pose a major survival problem in countries not attacked. The level of strontium 90 deposited from long-term fallout would be higher than the maximum permissible concentration recommended for the population as a whole on a peacetime standard, but lower than the recommended maximum permissible occupational dose under controlled conditions.

(2) The actual release of gamma radiation energy from fission products differs significantly from that represented by the standard formula ($t^{-1.2}$ rule) contained in the official Government publication, "The Effects of Nuclear Weapons." New calculations indicate that early dose rates will be of greater intensity than previously believed and that over a long period of time the rate of decline will be more rapid. While the problem of immediate survival in a nuclear war is thus increased, the problem of long-term recovery is reduced.

(3) Local fallout is significantly affected by wind and weather. Actual fallout contours will differ markedly from the idealized cigar-shaped patterns normally used as a basis of estimating fallout effects. Moreover, peak fallout intensities will almost never occur at or near the point of weapon detonation. For example, the maximum fallout intensity for a weapon of a 5- to 10-megaton yield may appear at a distance as great as 60 to 70 miles from the point of detonation.

## SURVIVAL MEASURES

Probably the most significant finding presented to the subcommittee was that civil defense preparedness could reduce the casualties of the assumed attack on the United States from approximately 30 percent of the population to about 3 percent. The provision of shielding against radiation effects would at the same time protect against blast and thermal effects for the vast majority of the population.

The cost of providing high-performance shelter protection for 200 million people was estimated at between $5 billion and $20 billion.

The main conclusion presented to the subcommittee was that the country must have a national radiological defense system if the Nation is to withstand and recover from an attack of the scale which is possible in an all-out nuclear war.

### STRATEGIC IMPLICATIONS

In the course of the hearings the subcommittee received testimony on some of the strategic implications of the scientific data presented. A digest of this testimony and related panel commentary is included in an addendum to the report.

## III. The Attack Pattern and Basic Assumptions

The attack pattern and basic assumptions established by the subcommittee for consideration in these hearings reflected an attack against the United States on a limited scale. That is, the number and total megatonnage of weapons employed were less than the maximum which a potential enemy is capable of launching against the United States.

At the same time, the pattern of the hypothetical attack was designed for a greater dispersion of weapons than would obtain in a so-called "limited" attack directed only against U.S. strategic offensive forces.

Although no classified information was utilized and the attack pattern was developed without assistance from any governmental agency, the realism of the assumptions was confirmed at the request of the subcommittee by competent military experts.

The targets in the United States were selected on the basis of criteria used by the Office of Civil and Defense Mobilization in its unclassified civil defense exercises and from published lists of military bases and Atomic Energy Commission installations.

The hypothetical attack consisted of 263 nuclear weapons delivered on 224 targets in the United States. The total megatonnage (millions of tons of TNT explosive equivalent) of the attack was 1,446, consisting of weapons ranging in size from 1 megaton to 10 megatons, as indicated in the following table:

Table III—1.—*Weight of the attack*

| Size of weapon | Number used | Weight of attack (megatons) |
|---|---|---|
| 10 megatons | 60 | 600 |
| 8 megatons | 74 | 592 |
| 3 megatons | 44 | 132 |
| 2 megatons | 37 | 74 |
| 1 megaton | 48 | 48 |
| Total | 263 | 1,446 |

Of the 224 targets, 71 were large industrial and population centers officially designated by the OCDM as "Critical Target Areas." Military installations constituted an additional 132 targets and the remaining 21 targets were Atomic Energy Commission facilities.

The following table indicates the dispersion of weapons among the several classes of targets:

TABLE III—2.—*Targets of the attack*

| Type of target | Number | Number of weapons | Weight (megatons) |
|---|---|---|---|
| Air Force installations | 111 | 111 | 645 |
| Critical target areas | 71 | 110 | 567 |
| AEC installations | 21 | 21 | 168 |
| Army installations | 12 | 12 | 24 |
| Navy installations | 5 | 5 | 28 |
| Marine Corps installations | 4 | 4 | 14 |
| Total | 224 | 263 | 1,446 |

All weapons were arbitrarily designated as 50 percent fission and 50 percent fusion weapons detonated at ground level, that is, with the fireball touching the earth's surface. Each weapon was assumed to have been detonated at or near its specified target by using a standard statistical method for random bombing errors.

The total of 1,446 megatons was considered the yield of the weapons detonated, not the gross attack which the aggressor force might have launched initially, and no attempt was made to "war game" the overall problem of weapon delivery, interception, and retaliation.

For purposes of computing worldwide fallout and its effects for a period of 5 years after the attack, again without war gaming, it was assumed that 2,500 megatons of weapons were detonated on areas of the Northern Hemisphere outside the continental United States, representing the net result of attacks on U.S. overseas bases and U.S. retaliatory strikes against the aggressor homeland.

The general distribution of targets in the United States is illustrated on the map in figure III—1.

The time of the hypothetical attack was set at 12 noon Greenwich time (7 a.m. eastern standard time) on a typical October day, which assumes completed harvest and storage of food crops in the aggressor homeland. The actual weather conditions used in plotting fallout patterns and determining the effects of meteorological factors were those recorded for October 17, 1958, a typical fall day. It was necessary to select a particular day in the past in order to provide the weather data for accurate calculations.

## IV. Basic Effects of Weapons Employed

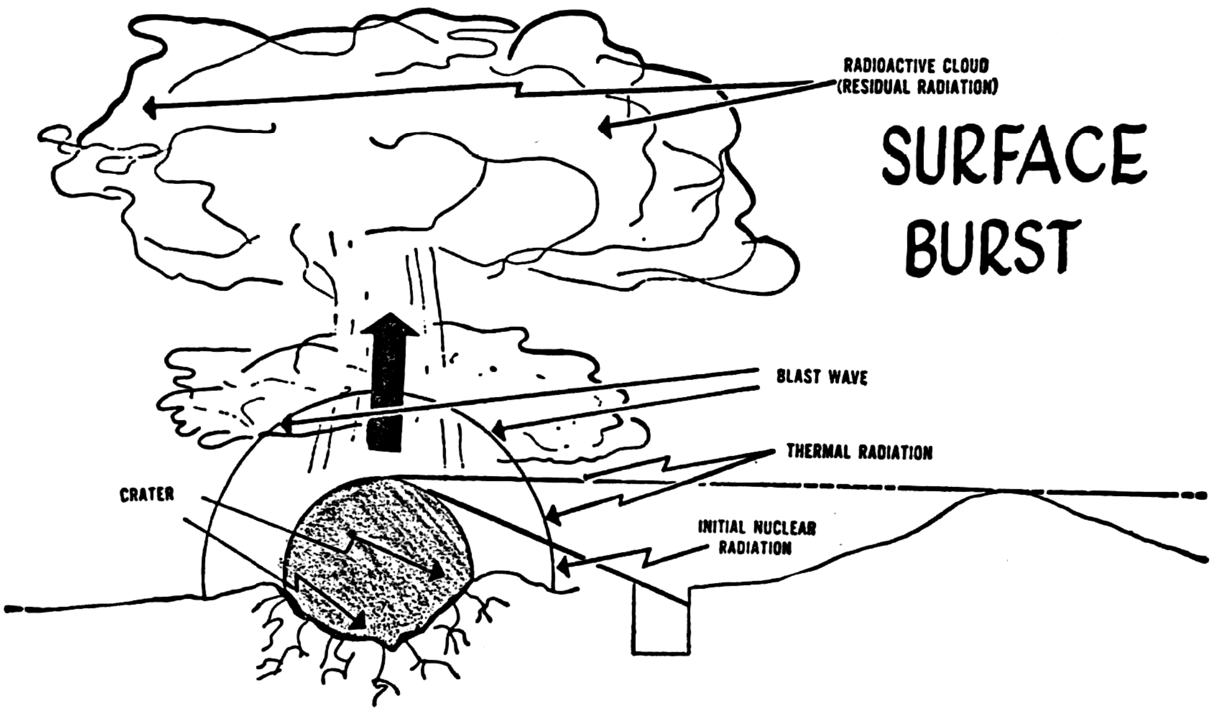
As indicated above, the weapons employed in the hypothetical attack assumptions consisted of 50 percent fission and 50 percent fusion weapons ranging in size from 1 to 10 megatons, all detonated at ground level. The following data concerning the basic effects of these weapons were presented at the subcommittee hearings. Later sections of this report will discuss the biological and environmental effects of these weapons in greater detail.

### 1. *Partition of energy in a nuclear explosion*

About 35 percent of the total energy of a nuclear explosion is given off as radiant thermal energy or heat, in much the same way as the sun radiates heat. Another 50 percent of the bomb energy is contained in the blast wave that travels several times the speed of sound. About

*Surface burst.*—A surface burst is one in which the fireball intersects the surface. (See fig. IV–2.) Local fallout is maximized in a surface burst. A crater is formed in the vicinity of the burst and is highly radioactive. The range of thermal and nuclear radiation effects is reduced by the natural shielding of hills and buildings.

FIGURE IV–2




*3. Nuclear weapons effects on materials and structures*

(1) *Blast.*—Multistory brick apartment houses are quite vulnerable to the blast wave. All such structures would be destroyed within a radius of 7 miles from ground zero for a 10-megaton weapon and within 3 miles for a 1-megaton burst. Thus, a factor of 10 in yield changes the radius of destruction by about a factor of 2.

A well-constructed wood-frame house completely collapses within 9 miles from a 10-megaton surface burst and within 4 miles of a 1-megaton burst.

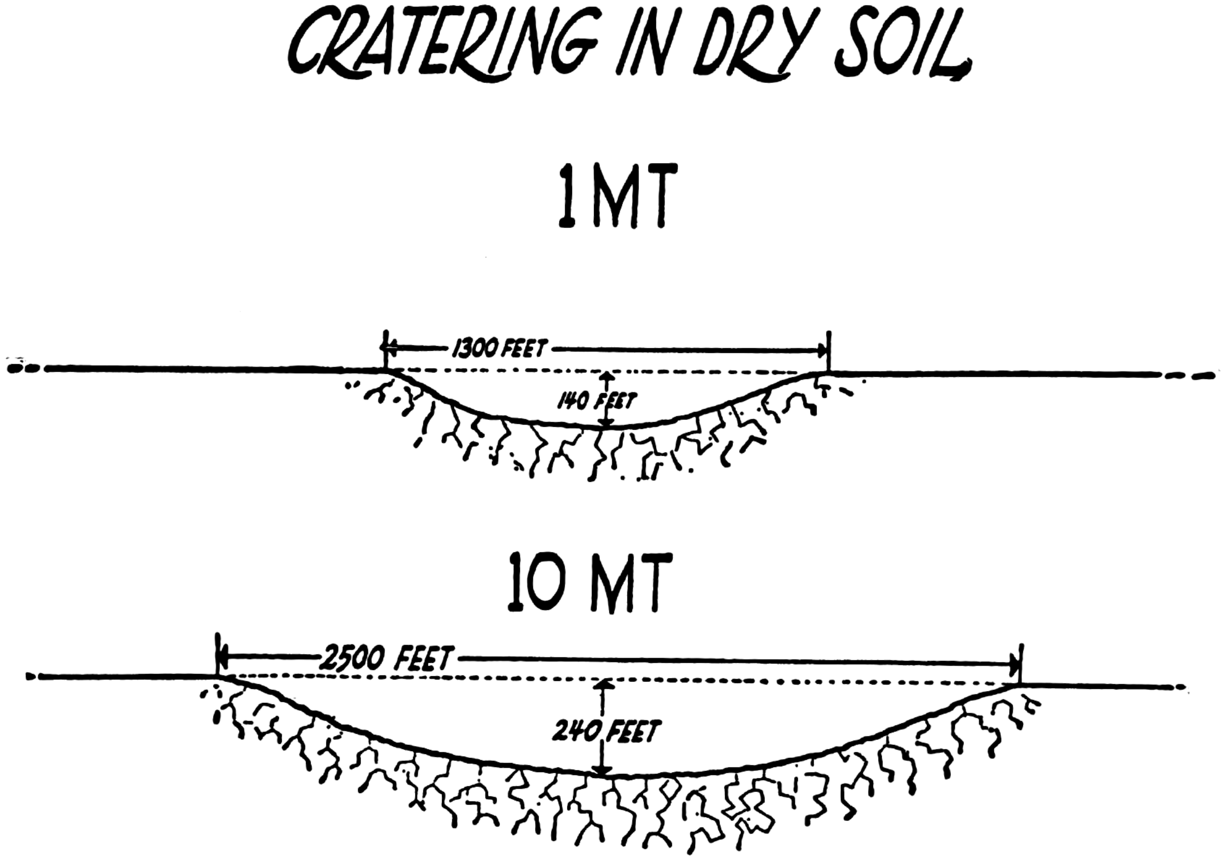
(2) *Thermal.*—Fires can be started by the ignition of light kindling materials anywhere within about 9 miles from a 1-megaton burst and within 25 miles from a 10-megaton burst. Thus, the presence of light kindling materials, such as trash, paper, and unpainted wood in a residential area will probably result in widespread fires.

(3) *Nuclear radiation.*—Initial nuclear radiation and fallout have very little effect on most inanimate materials. However, fallout can deny the use of inanimate objects to man until they are decontaminated by removing the radioactive particles.

(4) *Crater.*—Such hard structures as underground installations are quite invulnerable to the other effects, but can be destroyed by the cratering effect of a surface burst. (See fig. IV–3.) The damage would not be confined to just the crater dimensions, but would extend also into the rupture zone, a region having a diameter about twice the

crater diameter. Almost no structure nor its occupants would survive within this region.

FIGURE IV-3




*4. Nuclear weapons effects on man*

(1) *Blast.*—Blast overpressure in itself is not a significant casualty agent. However, the secondary effects and injury caused by crumbling buildings, flying debris, and man himself being thrown about, are certainly significant. Extensive blast injury can be expected at distances at which brick apartment houses collapse (7 miles from 10 megatons and 3 miles from 1 megaton). Extensive window breakage and flying glass would also occur at these and somewhat greater distances.

(2) *Thermal.*—Second degree burns of the hands or face will incapacitate an individual. For a 1-megation burst, an exposed person 9 miles from ground zero on a clear day can be expected to receive second degree burns on the exposed skin. For a 10-megaton burst, this range would be less than three times as great, or about 25 miles.

(3) *Initial radiation.*—Nuclear radiation is measured in units of rem (roentgen equivalent mammal). A rem is defined as the amount of radiation of any type required to produce a biological effect equivalent to that of 1 roentgen of X-ray. Two hundred rem will cause vomiting and nausea in 50 percent of a group of people by the end of the first day, but none or very few would be expected to die. A dose of 450 rem would cause vomiting and nausea in all of a group by the end of the first day, and according to the official handbook entitled "The Effects of Nuclear Weapons,"[8] about half of the people so exposed would be expected to die within 30 days. This is termed the

[8] "The Effects of Nuclear Weapons," prepared by the U.S. Department of Defense and published by the U.S. Atomic Energy Commission, Washington: U.S. Government Printing Office, 1957.

### SUMMARY OF EFFECTS FOR 1-MEGATON AND 10-MEGATON NUCLEAR WEAPONS

Blast, which is primarily a damaging agent to inanimate objects such as buildings, produces flying debris which is a hazard to man. The cratering effects result in the destruction of even deep underground structures.

Thermal radiation damages both humans and combustible structures and materials.

Nuclear radiation, including both the initial and residual fallout are primarily hazards to man and animals.

The distances and areas covered by various effects are contained in the following table:

TABLE IV–1.—*Summary of effects of the assumed nuclear weapons 1 to 10 megatons*

| | 1 megaton | 10 megatons |
|---|---|---|
| A. Inanimate objects: | | |
| 1. Crater (dry soil) | Radius, 650 feet; depth, 140 feet. | Radius, 1,250 feet; depth, 240 feet. |
| 2. Brick apartment houses collapse. | Radius, 3 miles | Radius, 7 miles. |
| 3. Ignition of light kindling materials. | Radius, 9 miles | Radius, 25 miles. |
| B. Man: | | |
| 1. Blast injury (flying debris) | Radius, 3 miles; area, 28 square miles. | Radius, 7 miles; area, 150 square miles. |
| 2. 2d degree burns on bare skin | Radius, 9 miles; area, 250 square miles. | Radius, 25 miles; area, 2,000 square miles. |
| 3. Initial nuclear radiation (700 rem). | Radius, 1.5 miles; area, 7 square miles. | Radius, 2 miles; area, 12.5 square miles. |
| 4. Fallout, 15-knot winds (450 rem in 48 hours, no shielding). | 40 miles downwind; 5 miles crosswind; area, 200 square miles. | 150 miles downwind; 25 miles crosswind; area, 2,500 square miles. |

## V. RADIOACTIVE FALLOUT PATTERNS, PHYSICAL DAMAGE AND CASUALTIES IN THE UNITED STATES

Based on the specific attack assumptions developed by the subcommittee, the Office of Civil and Defense Mobilization prepared a damage assessment with respect to blast, thermal, and fallout effects on dwellings and people during the period of 90 days following the attack.

While the primary effects of nuclear explosions may claim the greatest number of victims, the threat of persisting radioactivity poses the greatest hazard to survivors. It was for this reason that the subcommittee devoted much of its investigation to the problem of radioactive fallout.

### FALLOUT PATTERNS

The fallout situation plotted by the OCDM is depicted on the maps reproduced in figures V–1, 2, 3, 4 and 5 showing conditions at the postattack time periods of 1 hour, 7 hours, 2 days, 2 weeks, and 3 months.

These maps show the progression of fallout across the United States during the first 2 days postattack and then indicate its subsequent retreat as radiation decay begins to predominate over further deposition of fallout. At 1 hour post-attack less than 10 percent of the country is affected by fallout but the dose rates are very high, exceeding 3,000 roentgens per hour in some areas. By 7 hours,

approximately 30 percent of the national land area is covered by fallout intensities exceeding 1 roentgen per hour; and after 2 days 46 percent of the national land area is affected by intensities ranging from one-tenth roentgen per hour to greater than 30 roentgens per hour. Two weeks after the attack, as a result of radiation decay, only 15 percent of the national land area has fallout intensities exceeding one-tenth roentgen per hour and after 3 months only 5.8 percent of the area is affected by this intensity.

Two important factors concerning these fallout data require special attention. First, it is important to distinguish between the radiation dose rates, indicated here, and total dose accumulation, that is, the total dose which an unsheltered person would receive in a given period of time at a specified geographic location. Secondly, the stated dose rates as computed by OCDM are based on the $t^{-1.2}$ decay principle, which is at variance with later findings of the U.S. Naval Radiological Defense Laboratory.

The $t^{-1.2}$ rule, which long has been accepted by the scientific community, simply means that in general the radiation intensity existing 1 hour after a nuclear explosion will decline by a factor of 10 for every sevenfold increase in time. That is, if the 1-hour postattack dose rate is 3,000 roentgens per hour, 7 hours after the explosion the rate will be 300 roentgens per hour. Forty-nine (7×7) hours after the explosion the rate will be 30 roentgens per hour. At 343 (7×7×7) hours after the explosion the rate will be 3 roentgens per hour.

Although the NRDL data suggest a slower initial decline in dose rate, they indicate a more rapid decline after 1 year. However, whether one uses the $t^{-1.2}$ rule or the NRDL data, the requirement for population shielding in the period immediately following a possible attack remains substantially the same. A fuller discussion of the NRDL data is contained in a later section of this report, beginning at p. 28.

With respect to total radiation doses, data presented at the hearings indicate that in some sections of the country the hypothetical attack would have produced accumulated doses exceeding 12,000 roentgens during the first 3 months. As pointed out by OCDM witnesses, this means that persons who survived the initial impact of the attack in such highly contaminated areas would have to be moved to safer locations.

It should be noted that the official OCDM position with respect to the radiation hazards of a possible nuclear war is that fallout shelters should be prepared for the entire population of the United States. Although the fallout projections in figures V–1, 2, 3, 4, and 5 show some areas of the country to be free of fallout and others to be contaminated with extremely low radiation intensities, such areas cannot be accurately predicted in advance of a possible attack because of variables in such factors as target selection, aiming errors, weapon sizes and weather conditions.

### DAMAGE SUSTAINED BY DWELLINGS

The blast damage sustained by dwellings in the United States as a result of the hypothetical attack is indicated in table V–1. Eleven million eight hundred thousand dwellings, or more than one-fourth of

the dwellings in the United States, suffered damage to the extent that they would not be salvageable.

An additional 8.1 million dwellings suffered moderate damage and would have to be evacuated for major repairs; and 1.5 million dwellings suffered light damage. This totaled 21.4 million dwellings damaged.

TABLE V–1.—*Effects on dwelling*

| | Units |
|---|---|
| Blast effects: | |
| Severe damage | 11, 800, 000 |
| Moderate damage | 8, 100, 000 |
| Light damage | 1, 500, 000 |
| Fallout effects: | |
| Greater than— | |
| 3,000 roentgens per hour | 500, 000 |
| 1,000 to 3,000 roentgens per hour | 2, 100, 000 |
| 100 to 1,000 roentgens per hour | 10, 400, 000 |
| Less than 100 roentgens per hour | 11, 700, 000 |

Outside the areas of blast and thermal damage, some 2,600,000 dwellings sustained radiation intensities exceeding 1,000 roentgens per hour and would have to be evacuated and abandoned for periods extending up to several months. An additional 10.4 million dwellings sustained radiation intensities varying between 100 and 1,000 roentgens per hour. With major decontamination effort most of these 10.4 million homes could be recovered by 60 days postattack.

In summary, almost 50 percent of existing dwellings in the United States were either severely damaged or contaminated by fallout to the extent that they would not be usable for at least several months postattack.

CASUALTIES

*Based on 1950 census data,* it was calculated that 19.7 million persons would have been killed the first day; 22.2 million additional persons would have been so badly injured that they would subsequently die of their injuries. There would have been approximately 17.2 million additional persons injured who could be expected to recover from the injuries received. Of those killed, 25 percent would have died from fallout and approximately 75 percent would have died as a result of blast and thermal injuries, combined to a great extent with radiation injuries.

Of the surviving injured, approximately 6.3 million would have blast and thermal injuries and 10.9 million would have radiation injuries.

Due to the population increase of approximately one-sixth since the 1950 census, it was noted that these casualty estimates might be increased by approximately 16 percent on a national basis. If this increase is included, the above casualty estimates would be changed to 22.8 million persons killed on the first day; 25.7 million additional persons fatally injured; and 19.9 million persons nonfatally injured. This increase, however, cannot be accurately applied to individual area estimates.

The charts which follow (tables V–2 and 3), again based on 1950 census data, show the numbers of fatalities and surviving injured by OCDM regional areas, by States, and within the 71 population and industrial centers included as targets in the hypothetical attack. It will be noted that of the total 19.7 million people killed on the first day, approximately 11.4 million were in the 12 largest metropolitan areas

in the United States. The New York City area sustained the greatest loss with over 6 million dead or dying and over 2 million surviving injured. Seventy-five percent of the persons living in the Boston area were killed, and in Los Angeles fatalities amounted to 65 percent. In Chicago fatalities amounted to only 18 percent of the population, while in Baltimore they approached 80 percent.

With respect to radiation casualties, it is important to note that the OCDM estimates assumed that the population would take advantage of the fallout protection provided by existing buildings. The protection factors used in these estimates ranged from a reduction to one-half for those afforded the worst protection to a reduction to one two-hundredth for those afforded the best protection. It is possible that some groups of the population would have less protection than one-half reduction and some would have better protection than one two-hundredth reduction, but in the opinion of the OCDM the differences in the national totals would not be significant.

A factor of considerable significance, however, is that the above radiation casualty estimates are based on the $t^{-1.2}$ radiation decay rule, rather than on the most recent decay data developed by the Naval Radiological Defense Laboratory. Estimates based on the NRDL data, and subsequently presented by the OCDM at the request of Chairman Holifield, indicate that there would have been 5.1 million more fallout fatalities and 1.6 million more nonfatal fallout casualties than the $t^{-1.2}$ assumption indicated. The totals would then be 53.6 million fatalities and 20.5 million nonfatally injured.

It should also be noted in this connection that an upward revision of the estimated LD 50 rate (the radiation dose at which one-half those exposed would be expected to die), as suggested by some witnesses, would reduce the overall casualty estimates to some extent.

The subcommittee believes it is also important to note that almost 100 million of our people (56 percent of the population) would have survived this hypothetical attack without suffering blast, thermal, or serious fallout effects. Further, as pointed out by the OCDM, more than 96 million people in the United States do not live in or near likely target areas and could be expected to survive a nuclear attack merely through the provision of fallout shelter and a 2 weeks' supply of food and water.

The subcommittee recognizes that the long-range problems of a post-nuclear-war period would be extremely difficult, but this phase of recovery and rehabilitation was not within the scope of these particular hearings. A study of this aspect of national survival might well be explored by an appropriate committee of Congress.

nation on clay or loam, or in a metropolitan industrial complex such as a city is not known.

From table VI–1 it can be seen that the particle size of the debris descending at a distance of 8 miles from the point of detonation is expected to be relatively large, whereas the average size of the material depositing at 60 miles downwind is relatively smaller. By comparison, the material drawn into the stratosphere and which contributes to worldwide fallout probably has a particle size of the order of 0.02 millimeter. Attention is called to the fact that the distribution of radioactivity within the fallout particles themselves is quite irregular and that the bulk of the radioactivity associated with these particles is related to the particle size. It is significant that the largest particles contain the most radioactivity.

TABLE VI–1.—*Physical properties of land-surface burst fallout*

| Properties of particles [1] | ~8-mile downwind [2] | ~60-mile downwind |
|---|---|---|
| General description | Melted, glassy solid containing air bubbles and mineral grains | |
| Range of diameters | ~0.075 to 1.5 millimeters | ~0.050 to 0.30 millimeter. |
| Predominant size | ~0.35 millimeter in diameter | ~0.10 millimeter in diameter. |
| Color | Transparent to opaque, pale green or yellow to brown or black | |
| Shape | Spherical to irregular | |
| Specific gravity | ~1.4 to 2.6 gm/cm [3] | |
| Distribution of radioactivity | Irregularly throughout | |
| Relation of radioactivity to size | $A \alpha D^{\sim 3}_{max}$ but with the range of A increasing with $D_{max}$ | |

[1] Based on properties of particles from kiloton bursts on silicate sand; all other information derived from megaton bursts on coral sand.
[2] ~: Approximately.

The chemical and radiochemical properties of the fallout material from a land-surface burst is summarized in the printed hearings. Less than 3 percent of the radioactivity associated with these large particles is soluble by leaching with water for several days. This implies that the radioactivity associated with these particles is not available for incorporation into plants and animals, at least for short periods of exposure to the elements. There is a significant list of radioactive isotopes which can be induced, either by neutron activation of materials within the weapon, or by activation of materials within the immediate environment, which under various conditions can contribute quite significantly to the quantity of gamma radiation associated with this fallout material. Testimony presented at the hearings indicated that the presence of such induced activities should be recognized and their presence ignored only after positive evaluation has indicated that it may be proper to do so.

Finally, it may be noted that under the conditions suggested in this exercise, as much as 90 to 95 percent of the fission products generated by the explosion could be found in the close-in or local fallout. This, of course, includes virtually all of the important gamma-emitting radioactive isotopes. However, due to the mechanism of formation as indicated in the preceding section, it is noted that only around 50 percent or less of the important isotopes strontium 90 and cesium 137 are found in the local fallout. Due to the mechanism of formation this fraction is highly variable but the general implication is that due to fractionation the gamma-emitting radioactive materials

which can create a radiation threat from fallout under conditions of nuclear war are preferentially pulled down in the local fallout, whereas the long-lived isotopes which are significant in worldwide fallout and as possible sources of difficulty under conditions of the testing of nuclear weapons in times of peace, are preferentially distributed through the worldwide fallout. These fractions are also very highly variable and are quite sensitive to the precise conditions of the detonation. For surface bursts the standard estimate from the weapon-test program is to assume 80 percent of the total weapon debris deposits as close-in fallout, 15 percent appears as stratospheric fallout, and 5 percent remains in the troposphere.

The ability of gamma radiation to penetrate through solid materials such as would be found in the walls of structures is directly related to the energy of the radiation. Naturally, with a mixture as diverse as that of the fission mixture, the range of the energies from the gamma radiation is quite wide. It varies from as low as 0.01 Mev.[12] to as high as 2.5 Mev. It is, however, of considerable interest to see how the average energy of this complex mixture will change as a function of time. These data are shown in table VI–2.

TABLE VI–2.—*Radiation characteristics of land-surface burst fallout*

[In million electron volts]

| Characteristics | 8-mile downwind | 60-mile downwind |
|---|---|---|
| Ionization decay rate: Average energy: | | |
| 1 hour | ---------- | 1.0 |
| 2 hours | ---------- | 0.95 |
| ½ day | ---------- | .60 |
| 1 day | ---------- | .40 |
| 1 week | 0.25 | .35 |
| 1 month | .45 | .65 |
| 2 months | .55 | .65 |
| 1 year | ---------- | .55 |

### *Arrival and deposition characteristics*

The principal arrival and deposition characteristics of a land surface detonation are summarized in table VI–3. At a distance of 8 miles from a 5-megaton detonation, the first fallout material can be expected to start arriving about 15 minutes after the detonation, to reach its peak at about 1.5 hours, and to be essentially completed in 6 hours. The total mass of dirt would amount to several tons per square mile at this distance, and the major portion would carry no radioactive material at all. However, a portion would carry radioactive debris, and the gamma radiation dose rate would start increasing at the time the first material arrived.

The gamma radiation rate would continue to increase for about 2½ hours, at which time the rate of radioactive decay would become equal to the rate of replenishment and the dose rate would level off and start decreasing by the end of 4 hours. After 6 hours, when the fallout ceased, the dose rate would diminish with a rate characteristic of the mixture of radioactive species that was present at that point.

At a distance of 60 miles, the time sequence would be very much the same, but slower. Fallout material would start arriving at about 7 hours after the detonation. It would reach a peak at 13 to 14

[12] Mev.: A unit of energy expressed in millions of electron volts.

altitude. In the real case, as a result of the fact that the material is not in a perfect terrain but has a finite depth, the radiation intensity first increases with altitude and then decreases as the height of the point over the cleared area is increased.

(5) The ratio of observed to calculated radiation intensities has also been found to vary with time. It was reported that in at least one case for measurements made in the Pacific, a ratio of 0.45 was found at 11 hours, 0.66 between 100 and 200 hours, and 0.56 between 370 and 1,000 hours after the detonation.

(6) According to the testimony, the influence of vegetation and trees, which could elevate some of the fallout material above the surrounding ground level, is very small when compared to radiation emanating from material on the ground. Specific corrections to allow for the presence of vegetation are not currently incorporated in estimates of the radiation intensities generated at a point as the result of fallout deposition.

(7) When the fallout occurs over a community, a number of departures from the estimates for an infinite flat plane occur. Part of the fallout that would have been deposited on the ground is, instead, deposited on the roof. This has the effect of reducing the predicted intensity by placing the source a greater distance away from the point of concern near the ground and also results in interposing material in the building structure between the fallout and the point of concern. The resulting reduction in radiation intensity was estimated to be as little as a factor of 2 in light frame residential buildings of the 1-story design, to a factor of 10 to 20 in the basements of 2-story residential buildings made of heavy material such as brick. Testimony also indicated that moderately simple protective measures such as could be provided by a combination of tables and sandbags could reduce the radiation intensities by as much as a factor of 100 in such a basement.

(8) Due to the intense scattering of both the immediate gamma radiation and neutrons from air, there is very little protection afforded to one building because it is surrounded by others. The radiation protection from that portion of the radiation dose which might come from the immediate gamma and neutron radiation would be changed by less than 50 percent due to the presence of other structures.

## VII. Biological Effects

### INTRODUCTION

The three basic casualty producing phenomena of a nuclear attack are (1) blast, (2) thermal, and (3) radiation. In an analysis of the biological effects of these phenomena it is necessary that they be considered singly and collectively and from the standpoint of the direct/prompt and the indirect/delayed effects.

Although it is unlikely that thermal burns, primary and secondary blast injuries, and radiation injury would occur singly in an appreciable portion of the casualties in those areas suffering heavy structural damage from weapons of any of the sizes employed in this attack, these effects were treated separately in the hearings in order that expert testimony from specialists in each field could be received.

Wherever possible, witnesses who have actively participated in human experience studies, i. e., the Hiroshima and Nagasaki surveys,

the Marshallese studies and the radiation accidents both in the United States and abroad were called.

In those areas where little or no human experience data exist, the most competent testimony, based upon extensive laboratory experimentation utilizing animals, was solicited.

### BLAST EFFECTS

The biological effects of blast were considered in four categories:

(a) Primary blast effects which cause lung damage and rupture of the eardrums due to the direct effect of the pressure wave on the body. In terms of peak overpressure in pounds per square inch, nuclear weapons blasts with their relatively sustained overpressures are much more efficient producers of casualties by a factor of 10 or more than are equivalent high explosive blasts. Nevertheless, lung hemorrhage and broken eardrums were uncommon in Japan. With 1- to 10-megaton weapons lung damage would be restricted to from 2.5 to 5.5 miles, which is well within the zone of destruction of brick apartment houses (3 to 7 miles). Ruptured eardrums might occur farther out—4.5 to 7.7 miles. In other words, serious to fatal primary blast injury is unlikely to occur as an isolated event.

(b) Secondary blast effects due to flying fragments which become missiles created by the pressure wave. This pressure or blast wave would produce injurious effects by propelling loose debris, broken glass or ceramics, and building materials to a velocity high enough to penetrate the human body. This effect is important out to 5 miles from a 1-megaton surface detonation and 11 miles with a 10-megaton surface detonation.

(*c*) Tertiary effects resulting from the body itself being thrown violently by the pressure wave. Human beings may become missiles upon being picked up and hurled laterally by the blast wave. These injuries are similar to automobile and aircraft accidents, and can occur to distances of 3 to 5 miles from a 1-megaton surface detonation and 7 to 16 miles for a 10-megaton surface detonation.

(*d*) Miscellaneous injuries due to ground shock (broken legs), dust, fires created by destruction of buildings, power lines and gas mains.

It was estimated that about 5 percent of the hazard from a 10-megaton surface detonation could be related to casualties resulting directly from the pressure wave (primary effect), and that about 95 percent of the casualties would result from missiles (secondary effects) and displacement (tertiary effects). It was also pointed out that, based on "free field" effects (i.e., likened to conditions which would obtain on a perfectly flat surface) the combined effects (blast, thermal, and initial ionizing radiation) varied with weapon yield. However, the effects would be encountered in the following sequence and combinations as one moves away from the point of detonation:

| | Fallout radiation | Thermal | Blast | Immediate radiation |
|---|---|---|---|---|
| Point of detonation | + | + | + | + |
| ↓ | + | + | + | − |
| Increasing distance from point of detonation | + | + | − | − |
| ↓ | + | − | − | − |

estimates of the predicted acute effects on man can be based directly on experimental data.

### SKIN BURNS FROM FALLOUT

The intensely radioactive fallout particles emit short-range beta radiations in addition to the penetrating gamma radiations. If fallout particles are lodged in direct contact with the skin, a skin burn can be created at that point. Doses in excess of 1,000 roentgens to the skin are required to produce severe burns. Good personal hygiene, by removing the fallout particles from the skin, can offset this effect. Beta burns, by creating open lesions, are easily infected. As a threat to survival, skin burns from fallout particles are much less important than the threat of whole-body gamma radiation under the exposure conditions of nuclear war. Pictures of actual skin burns on the Rongelap natives following the event of March 4, 1954, were displayed to the subcommittee during the hearings. It is significant to note that these burns were observed although the natives had been removed from the islands before a lethal dose of penetrating gamma radiation had accumulated. The testimony indicated that problems from this effect would become more significant during times of recovery when the threat to immediate survival had passed.

### INHALATION HAZARD FROM FALLOUT

Little quantitative data is available on the inhalation hazard from fallout, but data from all field tests and on the Rongelap (Marshall Islanders) people as well as from inhalation experiments in animals all suggest that in a relatively heavy fallout field: (1) the dose to the lung is unimportant compared to the total body radiation from the fallout field itself, (2) the dose to the lung is less than to the gastrointestinal tract even in the absence of eating contaminated food, and (3) that the dose to the thyroid gland from the $I^{131}$ (iodine) (because $I^{131}$ concentrates there) could be the largest dose received by any single organ of the body, in the absence of shelter in some fallout exposure situations.

### INGESTION HAZARD FROM FALLOUT

Ingestion of fallout debris could result in much larger internal radiation exposures than inhalation, yet still be of lesser concern than the external radiation for unshielded persons. During the critical weeks following the attack ingested fallout material would be almost entirely from surface contamination. The principal potential hazards from ingestion of fallout for several weeks after a nuclear detonation would be the exposure of the gastrointestinal tract itself and exposure to the thyroid gland from deposition of $I^{131}$ therein.

Theoretical studies suggest that radiation doses to the adult thyroid may be two or more times greater than to the intestines from ingestion of fallout material during most of the critical period. However, a 1,000- to 2,000-roentgen dose to the intestines would threaten survival, whereas the adult thyroid can normally withstand tens of thousands of roentgens before serious effects occur. Children's thyroids are more sensitive and the chance of late cancer from irradiation would be

TABLE IX-1.—*Survival arithmetic*

[Heavy fallout area: 3,000 roentgens per hour at 1 hour]

| | *Roentgens* |
|---|---|
| Dose during 1st year | 12,000 |
| Dose during 1st 2 weeks | [1] 10,000 |
| Dose between 2 weeks and 1 year | [2] 2,000 |

| Shelter shielding factor | Emergency dose | Reduction factor | Operational recovery dose |
|---|---|---|---|
| | *Roentgens* | | *Roentgens* |
| 10 | 1,000 | 10 | 200 |
| 100 | 100 | 100 | 20 |
| 1,000 | 10 | 1,000 | 2 |
| 10,000 | 1 | | |

[1] Emergency phase: 10,000 roentgens.
[2] Operational recovery phase: 2,000 roentgens.

This table shows that for the fallout condition used—

(1) A shielding factor of 10 is inadequate since a radiation dose of 1,000 roentgens is lethal.[18]

(2) A shielding factor of more than 1,000 is not profitable since 10 roentgens is less than 10 percent of the dose required to cause direct casualties. This implies acceptance of the corresponding nonrecoverable biological effects.

(3) A shielding factor of 100 would be adequate if the initial fallout level corresponded to a standard intensity of 300 roentgens per hour at 1 hour instead of 3,000 roentgens per hour at 1 hour.

Different combinations of useful radiological defense systems which relate different combinations of shielding effectiveness, stay time in the shelter, reclamation effectiveness, and radioactive decay properties are summarized in table IX-2.

TABLE IX-2.—*Useful radiological defense systems*

[Heavy fallout area: 3,000 roetgens per hour at 1 hour]

| System No. | Emergency phase countermeasures | Operational recovery phase countermeasures | Dose during 1st year (roentgens) |
|---|---|---|---|
| 1 | 6-month shelter with 0.01 residual number | None | 320 |
| 2 | 6-month shelter with 0.001 residual number | None | 210 |
| 3 | 2-week shelter with 0.01 residul number | 0.1 reclamation | 300 |
| 4 | 2-week shelter with 0.001 residual number | do | 210 |
| 5 | 2-week shelter with 0.01 residual number | 0.01 reclamation | 120 |
| 6 | 2-week shelter with 0.001 residual number | do | 30 |

Other factors relating to a national system may be summarized as follows:

(1) The need for a formal radiological defense system disappears at fallout levels less than a standard intensity of 100 roentgens per hour at 1 hour. The protection afforded by existing buildings is generally adequate for this condition.

(2) Most buildings offering a shielding factor of 100 or more are located in metropolitan centers and will be vulnerable to the effects of blast and fire if that area is a target.

[18] A *shielding factor* of 10 is provided in the basement of some two-story homes. See "The Effects of Nuclear Weapons," p. 404. The corresponding *residual number* which relates the dose in the unprotected condition to the dose with the countermeasure is 0.1.

(3) Where such protection does exist, additional provisions for ventilation, food and sanitation would have to be made.

(4) Very good protection can be provided by underground shelters. The best information available is for a particular design based on a 24- by 48-foot ammunition-storage magazine [19] buried under 3 feet of earth. This shelter was occupied by technical personnel at Operation PLUMBOB [20] at a distance of somewhat less than 1 mile from a 17-kiloton detonation. A documentary film shown at the hearings gave an impressive demonstration of its effectiveness.

(5) The USNRDL shelter provides for 100 people at an estimated cost of $100 to $125 per person sheltered. It provides a shielding factor for radiation of 1,000 or more, and protection against blast at a level of 10 pounds per square inch. Protection against mass fires can also be provided.

(6) The USNRDL shelter can be designed for protection against a blast pressure of 35 pounds per square inch. Availability of such protection under conditions of the subcommittee's hypothetical attack could reduce the fatalities from approximately 25 percent of the U.S. population to about 3 percent. All of these would result from the immediate blast effects—no deaths from either thermal or nuclear radiation being anticipated under these conditions.

(7) The cost of providing protection for 200 million people at the levels prescribed by the higher performance defense system was estimated as between $5 billion and $20 billion, depending on the use made of existing facilities. This cost is almost entirely in the shelter phase, since reclamation competence is largely a matter of training and organization.

(8) The main conclusion presented to the subcommittee was that the country must have a national radiological defense system if the Nation is to withstand and recover from an attack of the scale which is possible in an all-out nuclear war.

In addition to data on group-type shelters, the subcommittee also received testimony on techniques of adapting present buildings for shelter purposes and proposals for individual family shelters.

Information bearing on these points may be summarized as follows:

(1) Techniques for estimating the degree of protection that can be obtained from existing buildings have recently been developed.

(2) On the first floor of a two-story wood building, the radiation was estimated to average about one-half of that outside. On the first floor of a brick building, it was one-seventh.

(3) Closing openings in basements with bricks or sandbags will reduce the radiation in the basement by a significant amount.

(4) Radiation dose rates inside fireplaces and behind masonry chimneys are lower than those in the center of the room.

(5) A heavy table covered with 7½ inches of concrete block and placed in the corner of a basement will reduce the radiation dose rate by a factor of 200 to 1,000 over that observed on the ground outside the structure.

(6) Prototype models of a combination transistorized portable radio and radiation detection unit were demonstrated at the hearings. This concept of a "citizen's instrument" is known as the "Banshee" because

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[19] This is basically a prefabricated building of the type known as a quonset hut.

[20] This test was conducted by the U.S. Naval Radiological Defense Laboratory under the sponsorship of the Atomic Energy Commission.

force that can absorb an enemy blow and still strike back with adequate strength and, second, certain minimum nonmilitary protection for the civilian population.

### TYPES OF DETERRENCE

It was also stated that even if the "balance of terror" theory were correct, the United States would still be faced with important strategic problems. As the witness pointed out, in 1914 and 1939, it was the British and the French who declared war on the Germans and not vice versa. It is difficult for Americans to realize that, under certain circumstances, neither the Soviets nor the Europeans might believe that the United States would come to the aid of Europe. In making this point, the witness asked the subcommittee to ponder a hypothetical situation in which American defenses were so weak and Soviet retaliatory forces so strong that if the United States responded to a Soviet ground attack on Europe the Soviet counter-retaliation would kill all 177 million Americans. Under such conditions, the witness said, it would not be surprising if neither the Europeans nor the Soviets found the U.S. promise to come to the aid of Europe credible. But if it is true that the Soviets and the Europeans would not believe that we would honor our commitments to our allies if it meant 177 million American deaths, what level of casualties do they believe we would accept? It was stated that, to the extent that the Soviets believe we can keep our casualties to a level we would find acceptable, whatever that level may be, they will be deterred not only from attacking the United States directly, but also from very provocative aggressions, such as a ground attack on Europe. But, it was said, to the extent that they do not believe we can keep casualties to an acceptable level, the Soviets may feel safe in undertaking these extremely provocative military adventures.

In discussing this aspect of the strategic problem facing the United States, the witness distinguished between what he called Type I deterrence and Type II deterrence. Type I deterrence, which the British call "passive deterrence" on the assumption that it requires no act of will to initiate a response, is the deterrence of a direct attack. If the United States were directly attacked, its response would be automatic. Type II deterrence, which the British have called "active deterrence" is defined as the forces necessary to deter an enemy from engaging in military adventures short of a direct attack on the United States itself. There is a question as to how effective nuclear retaliatory forces would be as a Type II, "active" deterrent. In pondering this question, it must be assumed that before launching on such an extremely provocative adventure, the enemy would have alerted his own retaliatory forces and instituted protective measures for his population. By such precautionary measures, the Soviets, according to the witness, might limit casualties to 10 percent of its population and one-third of its wealth. This is just about what they suffered in World War II, from which they had recovered by 1951. If the Soviets believed that they could limit destruction to this extent and were also convinced that the United States had failed to take the measures that would similarly limit destruction in the United States, they might well feel free to launch an aggressive attack.

Put another way, the subcommittee was told, a very moderate shelter program, which would combine protection against fallout and some blast resistance, could reduce the expected casualties to approximately one-third of those who would die if there were no protection at all. A more extensive program, designed to protect persons in our urban areas, could reduce the overall fatalities of this attack from 25 percent of the population to approximately 3 percent.

Such measures were believed not to be terribly expensive. The subcommittee was told that the program of fallout shelters, which would go far toward saving the lives of the 60 percent of all Americans who do not live in or near target areas, is one which depends on simple tools and simple techniques. The lives of millions could be saved or lost by a simple choice. Thus, one eminent witness pointed out that on the basis of the 1954 thermonuclear detonation at Bikini, where the area of blast and thermal effects was perhaps 300 square miles (a circle with a radius of 9¾ miles), the total area of likely radiation casualties was approximately 7,000 square miles. Clearly, the subcommittee was told, it is the people in the intermediate 6,700 square miles about whom something could be done: "We can save them easily; we can lose them easily."

The burden of the testimony received on this point was that if such protective measures were taken, the impact of America's ability to survive a nuclear war would be so great that the likelihood of such a war would be vastly reduced. So long as the Soviets have the advantage of forewarning and can reduce their already low vulnerability through a comprehensive civil defense program, the United States will be at a marked disadvantage. Its firm foreign policy will be open to doubt and disbelief, and to possible blackmail.

Thus, it was suggested that our lack of a civil defense program could lead the Soviets to take a provocative step which we could not ignore, and a nuclear war would have started with no protection for the American people. Or, as a final paradox, the subcommittee was told, in a world of great tension the Soviets may be unable to believe that we would allow an aggressor to strike us first, which the theory of "massive retaliation" implies. The acceptance of such a military disadvantage as a basis for our national policy may seem foolish to them. They may therefore discount the sincerity of our position and expect instead that the United States actually intends to strike the first blow. A war which neither side wanted could thus break out because of our defensive weakness.

# AMERICA IS IN DANGER

by General Curtis E. LeMay

$5.95

# AMERICA IS IN DANGER

## by General Curtis E. LeMay

"America is in danger. . . . We find ourselves in a purely defensive role, unable to make our will felt even in a conflict with a backward jungle country. . . . Our strategic nuclear superiority has given us much diplomatic strength in the past. Do we still have that strength? Do we have enough faith in our general war capability to prevail in a crisis? I think not. That is why America is in grave danger."

In this book Gen. Curtis E. LeMay—former member of the Joint Chiefs and first commander of the Strategic Air Command—closely analyzes and challenges the government's claim to have greatly strengthened our military position. He finds minor improvements in conventional forces, but actual reductions in nuclear capability and an over-all decline compared to Soviet forces.

General LeMay, while stressing the paramount need for civil control of the military, attacks civilian manipulation of technical military decisions as unprecedented and disastrous.

*(continued on back flap)*

*(continued from front flap)*

Assessing the strategic situation, General LeMay argues that our former policy of overwhelming nuclear superiority proved itself during the crises in Berlin, Taiwan, and Cuba, and produced twenty years of relative peace. Yet the current Administration has opted for a new and untested posture that permits, even encourages parity with Russia.

According to the author, we have fostered disunity in NATO—first, by failing to sign a German peace treaty (General LeMay proposes what he believes to be a workable solution), and second, by our nonproliferation policy, which, combined with complete dependence on massive retaliation for deterrence, has caused European leaders to question our nuclear guarantees.

While approving the decision to produce a thin-line antiballistic missile defense, General LeMay pleads for an urgent upgrading of this program, pointing to Russia's rapidly growing ABM force.

Finally, General LeMay analyzes our limited war strategy with particular reference to Vietnam and proposes immediate steps to insure not simply a military victory but a stable political and social solution.

As a man who has devoted his life to America's security, the author strongly believes that present defense policies endanger our ability to survive. In this urgent and thoughtful book General LeMay not only criticizes; he offers alternate solutions to bolster our strength and preserve peace.

FUNK & WAGNALLS
NEW YORK

Jacket design: Paul Bacon Studio

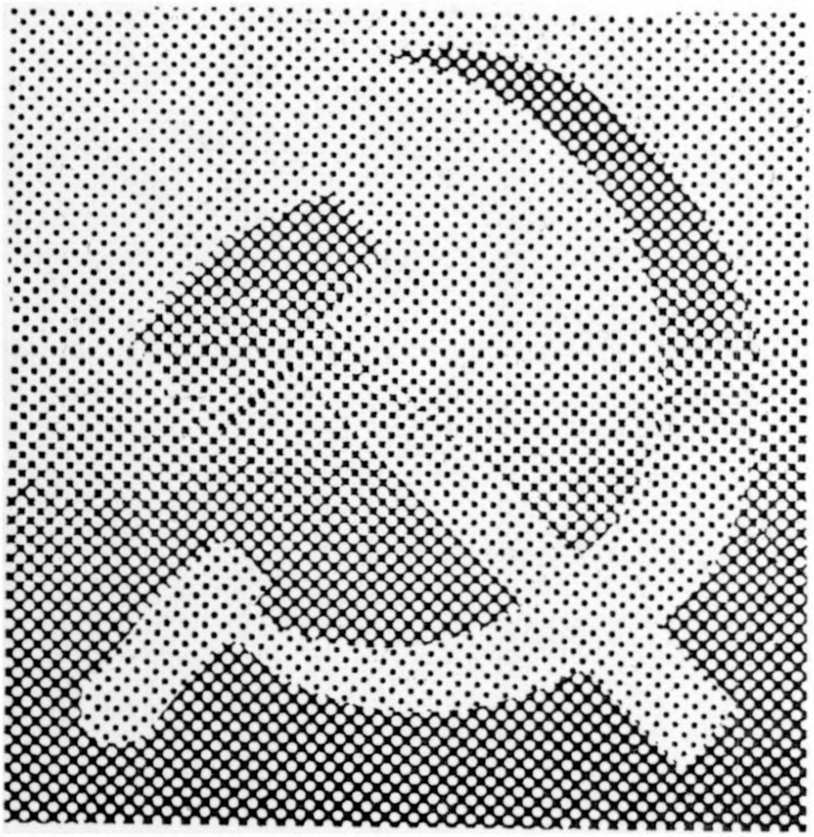
U.S.

**Spencer Weart, Never at War: Why Democracies Will Not Fight One Another, Yale University Press, 1998:**

**"This idea had been developed by 1785 ... A world where every state was a democracy, [Immanuel Kant] wrote, would be a world of perpetual peace. Free peoples ... will make war only when driven to it by tyrants. ... there have been no wars between well-established democracies. ... the absence of wars between well-established democracies [has a probability of being coincidence] less than one chance in a thousand. ... robust statistics ... When toleration of dissent has persisted for three years ... a new republic [is] 'well established.' ... [Diplomatic pacifism made war by the 'appeasement trap' of trying to 'accommodate a tyrant.'] ... the tyrant concluded that he could safely make an aggressive response ... [thus] negotiating styles are not based strictly on sound reasoning."**

# Military Psychology

## A Soviet View




Edited by:
V.V. SHELYAG
A.D. GLOTOCHKIN
K.K. PLATONOV



Moscow 1972

TRANSLATED AND PUBLISHED
UNDER THE AUSPICES OF
THE UNITED STATES AIR FORCE

# ВОЕННАЯ ПСИХОЛОГИЯ

**УЧЕБНИК**
**ДЛЯ ВЫСШИХ ВОЕННО-ПОЛИТИЧЕСКИХ УЧИЛИЩ СОВЕТСКОЙ АРМИИ И ВОЕННО-МОРСКОГО ФЛОТА**

*Под редакцией*
*В. В. ШЕЛЯГА,*
*А. Д. ГЛОТОЧКИНА,*
*К. К. ПЛАТОНОВА*

**Ордена Трудового Красного Знамени**
**ВОЕННОЕ ИЗДАТЕЛЬСТВО**
**МИНИСТЕРСТВА ОБОРОНЫ СССР**
**МОСКВА—1972**

## Chapter 28. The Psychology of Agitation and Propaganda Activity

"Propaganda" and "agitation" are words of Latin origin. To propagandize means to disseminate knowledge, ideas, views, and theories, while to agitate means to stir up definite aspirations and arouse people to action.

However, the essence of our Party and Leninist propaganda is significantly deeper. It must not only disseminate and transmit revolutionary ideas, but also make them the convictions of the people. By agitation, we mean a direct appeal and ability to direct the energy and will of the people to struggle for carrying out the ideas of communism in practice.

A scientific explanation of the essence of communist propaganda and agitation as well as their unity and differences was provided by V. I. Lenin.

V. I. Lenin in his work *Chto Delat'?* (What Is to be Done?), from the example of explaining the question of unemployment to the masses, showed the difference between propaganda and agitation: ". . . The propagandist, if he takes, for example, the same question of unemployment, should explain the capitalist nature of the crises, show the cause of their inevitability in modern society, sketch the necessity of transforming it into a socialist society, and so forth. In a word, he should provide 'many ideas,' or so many ideas that all these ideas at once, in their aggregate, will be assimilated by only a few (comparatively) persons. But an agitator, in speaking on the same question, takes the most outstanding example or one which is best known to his listeners . . ."

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"The art of any propagandist or agitator," stressed V. I. Lenin, "is in influencing a given audience in the best way, and making a certain truth for the audience as convincing as possible, as easy to assimilate as possible, and as visibly and strongly memorable as possible." V. I. Lenin, *Poln. sobr. soch.*, Vol 21, p 21.

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Convincingness is achieved by the propagandist's profound knowledge of theoretical problems and practical questions which he explains. A propagandist's speech is notable in its vivid exposition of the basic thought and main idea, reinforced with rich factual material, and enrichment of the listeners with new knowledge.

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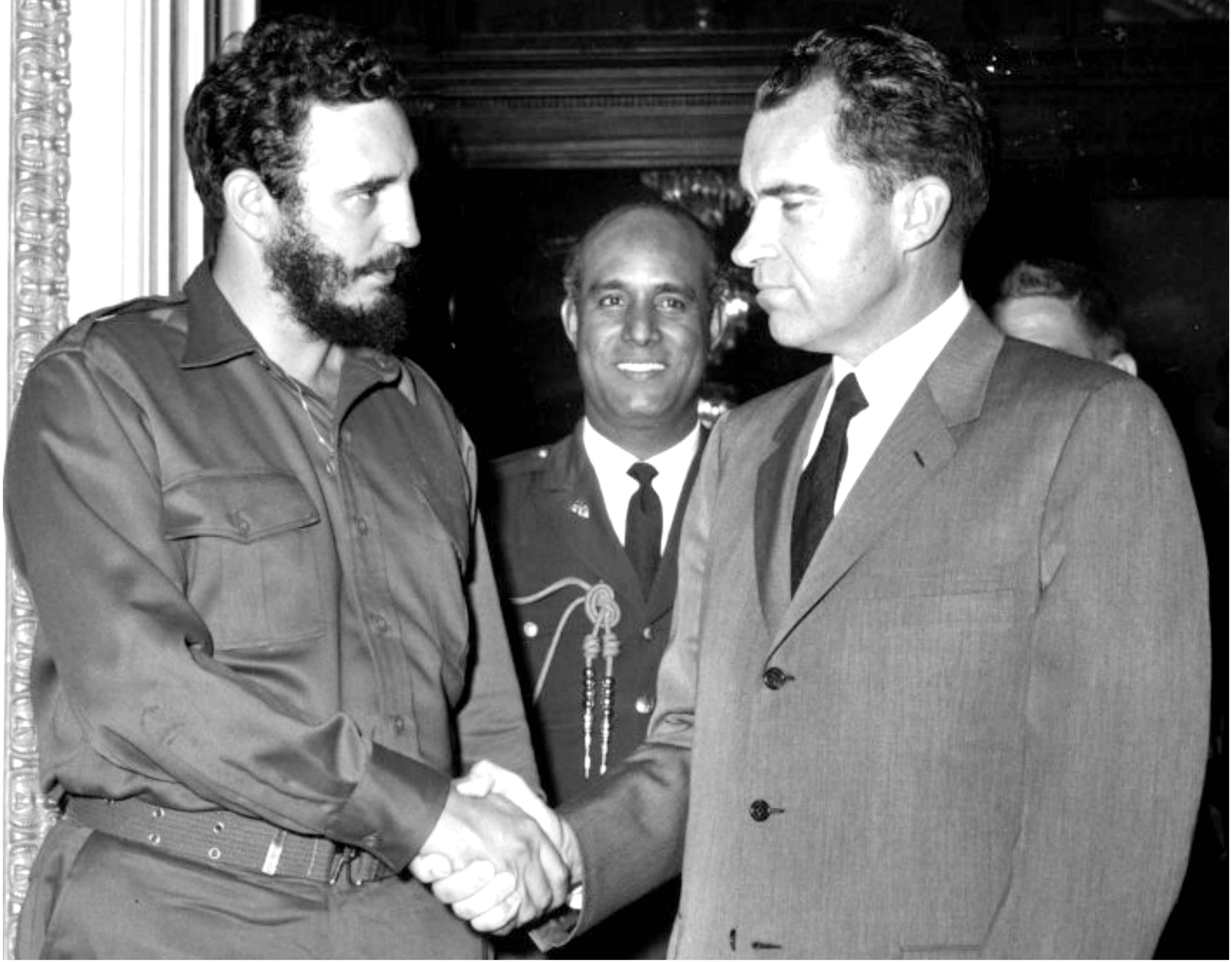
In propaganda, it is advisable to limit oneself in using obvious and reliable judgments, for an abundance of them frees the listener from the need to think, and teaches dogmatism.

*Fourth, the words of an agitator will be convincing if and when these words are theoretically argued with sufficient profundity.* The talk of an agitator is not only a conversation on current subjects, but also an explanation of a certain idea or theory. Only profound understanding of this idea by the masses will raise their revolutionary activeness which the agitator directs by his appeals in the appropriate manner. For this reason, a true agitator is a politically intelligent and ideologically convinced fighter for the Party. The best agitators are political workers, commanders, engineers, progressive-minded personnel, soldiers, and sergeants whose words are an authority for comrades.

*Fifth, agitation cannot be effective if it is not capable of becoming a means for an emotional effect upon the listeners.* The agitator influences the audience not only by his words, but by the entire range of his human personality, how he proves the theoretical theses, and by his tone and demeanor. The vivid and lively language of an agitator, and the most successful and intelligent form found by him for expressing an idea are important factors helping to carry out the agitation passionately and convincingly.

The observance of the listed conditions, which provide for the effectiveness of an agitator's talk, requires from him certain qualities, profound knowledge, high personal culture, combat and methodological preparation, ability to think logically, as well as the capability to come into contact with different people.



April 21, 1959 Cuban President Fidel Castro and Vice President Nixon

June 3, 1961: Nikita Khrushchev and John F. Kennedy in Vienna

C00012335 CENTRAL INTELLIGENCE AGENCY
WASHINGTON 25, D. C.

# CIA 12 March 1962

12 MAR 1962

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : MILITARY THOUGHT: "Some Factors Affecting the Planning of a Modern Offensive Operation", by Colonel-General Ye. Ivanov

1. Enclosed is a verbatim translation of an article which appeared in the TOP SECRET Special Collection of Articles of the Journal "Military Thought" ("Voyennaya Mysl") published by the Ministry of Defense, USSR, and distributed down to the level of Army Commander.

2. In the interests of protecting our source, this material should be handled on a need-to-know basis within your office. Requests for extra copies of this report or for utilization of any part of this document in any other form should be addressed to the originating office.

Richard Helms

Richard Helms
Deputy Director (Plans)

Following is a verbatim translation of an article titled "Some Factors Affecting the Planning of a Modern Offensive Operation", written by Colonel-General Ye. Ivanov.

This article appeared in the 1960 Second Issue of a special version of Voyennaya Mysl (Military Thought) which is classified TOP SECRET by the Soviets and is issued irregularly.

* * *

Weakening the nuclear strength of an opposing grouping of the enemy and depriving him of his capability to use nuclear weapons is one of the most important tasks, whose correct solution ensures the success of the offensive operation as a whole.

* * *

The mass utilization of nuclear weapons in short periods of time is the only way to achieve decisive destruction of the fire power of an opposing enemy grouping, destruction of his main nuclear/missile and aviation means, and also disruption of the control of troops and the disorganization of work of the rear services.

U.K. National Archives:

**Extracts from Khrushchev's letter to Kennedy, 26 October 1962 (Catalogue ref: PREM 11/3691)**

S E C R E T

QUOTE

Dear Mr. President:

I have received your letter of October 25. From your letter, I got the feeling that you have some understanding of the situation which has developed and (some) sense of responsibility. I value this.

Now we have already publicly exchanged our evaluations of the events around Cuba and each of us has set forth his explanation and his understanding of these events. Consequently, I would judge that, apparently, a continuation of an exchange of opinions at such a distance, even in the form of secret letters, will hardly add anything to that which one side has already said to the other.

I think you will understand me correctly if you are really concerned about the welfare of the world. Everyone needs peace: Both capitalists, if they have not lost their reason, and still more, Communists, people who know how to value not only their own lives but, more than anything, the lives of the people. We, Communists, are against all wars between states in general and have been defending the cause of peace since we came into the world. We have always regarded war as a calamity, and not as a game nor as a means for the attainment of definite goals, nor, all the more, as a goal in itself. Our goals are clear, and the means to attain them is labor. War is our enemy and a calamity for all the peoples.

It is thus that we, Soviet people, and, together with us, other peoples as well, understand the questions of war and peace. I can, in any case, firmly say this for the peoples of the Socialist countries, as well as for all progressive people who want peace, happiness, and friendship among peoples.

I see, Mr. President, that you too are not devoid of a sense of anxiety for the fate of the world, of understanding, and of what war entails. What would a war give you? You are threatening us with war. But you well know that the very least which you would receive in reply would be that you would experience the same consequences as those which you sent us. And that must be clear to us, people invested with authority, trust, and responsibility. We must not succumb to intoxication and petty passions, regardless of whether elections are impending in this or that country, or not impending. These are all transient things, but if indeed war should break out, then it would not be in our power to stop it, for such is the logic of war. I have

participated in two wars and know that war ends when it has rolled through cities and villages, everywhere sowing death and destruction.

In the name of the Soviet Government and the Soviet people, I assure you that your conclusions regarding offensive weapons on Cuba are groundless. It is apparent from what you have written me that our conceptions are different on this score, or rather, we have different estimates of these or those military means. Indeed, in reality, the same forms of weapons can have different interpretations.

You are a military man and, I hope, will understand me. Let us take for example a simple cannon. What sort of means is this: offensive or defensive? A cannon is a defensive means if it is set up to defend boundaries or a fortified area. But if one concentrates artillery, and adds to it the necessary number of troops. Then the same cannons do become an offensive means, because they prepare and clear the way for infantry to attack. The same happens with missile - nuclear weapons as well, with any type of this weapon.

You are mistaken if you think that any of our means on Cuba are offensive. However, let us not quarrel now. It is apparent that I will not be able to convince you of this. But I say to you: You, Mr. President, are a military man and should understand: Can one attack, if one has on one's territory even an enormous quantity of missiles of various effective radiuses and various power, but using only these means? These missiles are a means of extermination and destruction. But one cannot attack with these missiles, even nuclear missiles of a power of 100 megatons because only people, troops, can attack. Without people, any means however powerful cannot be offensive.

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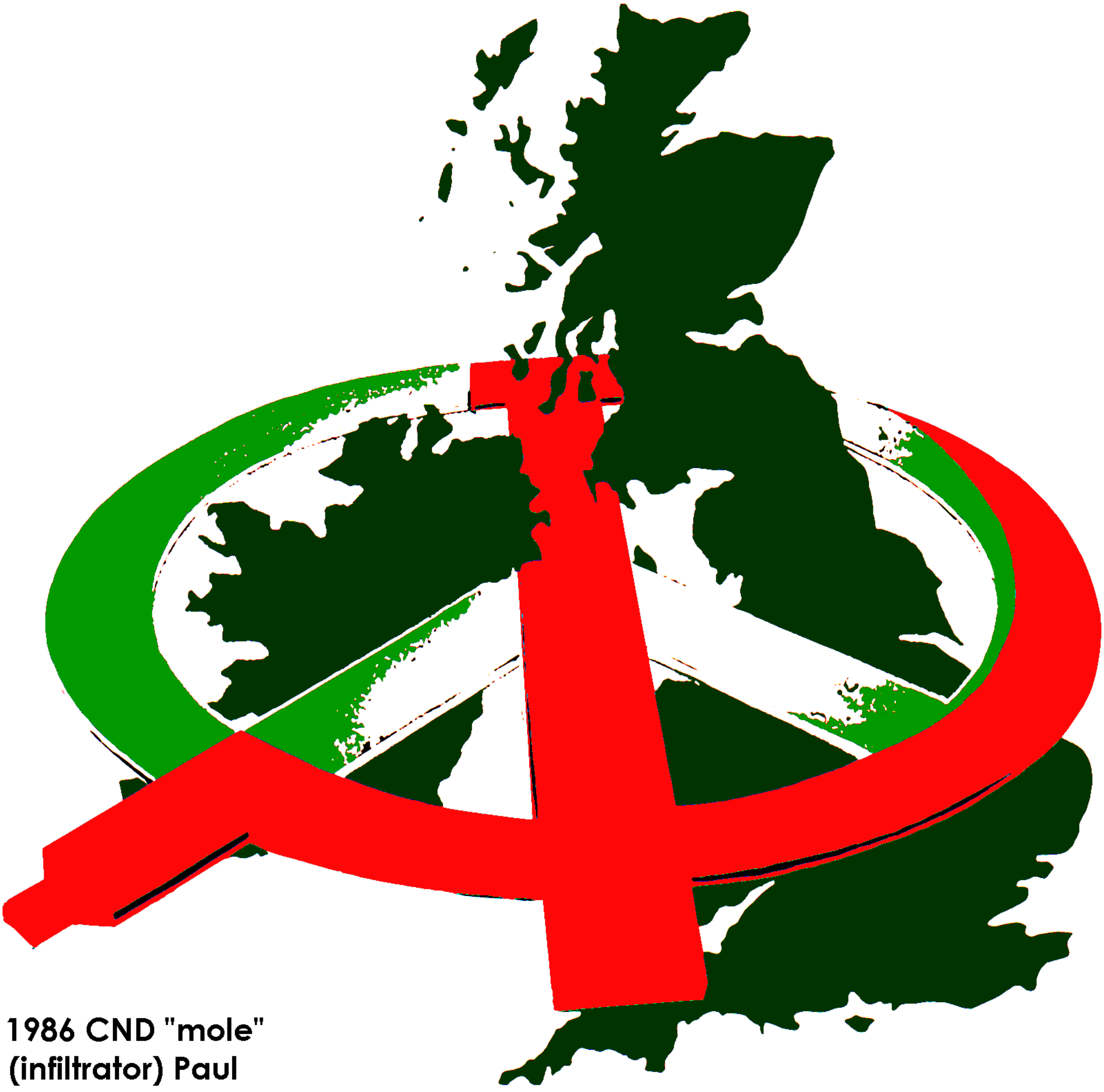
Armaments bring only disasters. When one accumulates them, this damages the economy, and if one puts them to use, then they destroy people on both sides. Consequently, only a madman can believe that armaments are the principal means in the life of society. No, they are an enforced loss of human energy, and what is more are for the destruction of man himself. If people do not show wisdom, then in the final analysis they will come to a clash, like blind moles, and then reciprocal extermination will begin.

Let us therefore show statesmanlike wisdom. I propose: We, for our part, will declare that our ships, bound for Cuba, will not carry any kind of armaments. You would declare that the United States will not invade Cuba with its forces and will not support any sort of forces which might intend to carry out an invasion of Cuba. Then the necessity for the presence of our military specialists in Cuba would disappear.

# 'PEACE' OF THE DEAD



1986 CND "mole"
(infiltrator) Paul
Mercer exposed
USSR propaganda

**Paul Mercer**

Foreword by Lord Chalfont, OBE, MC, PC

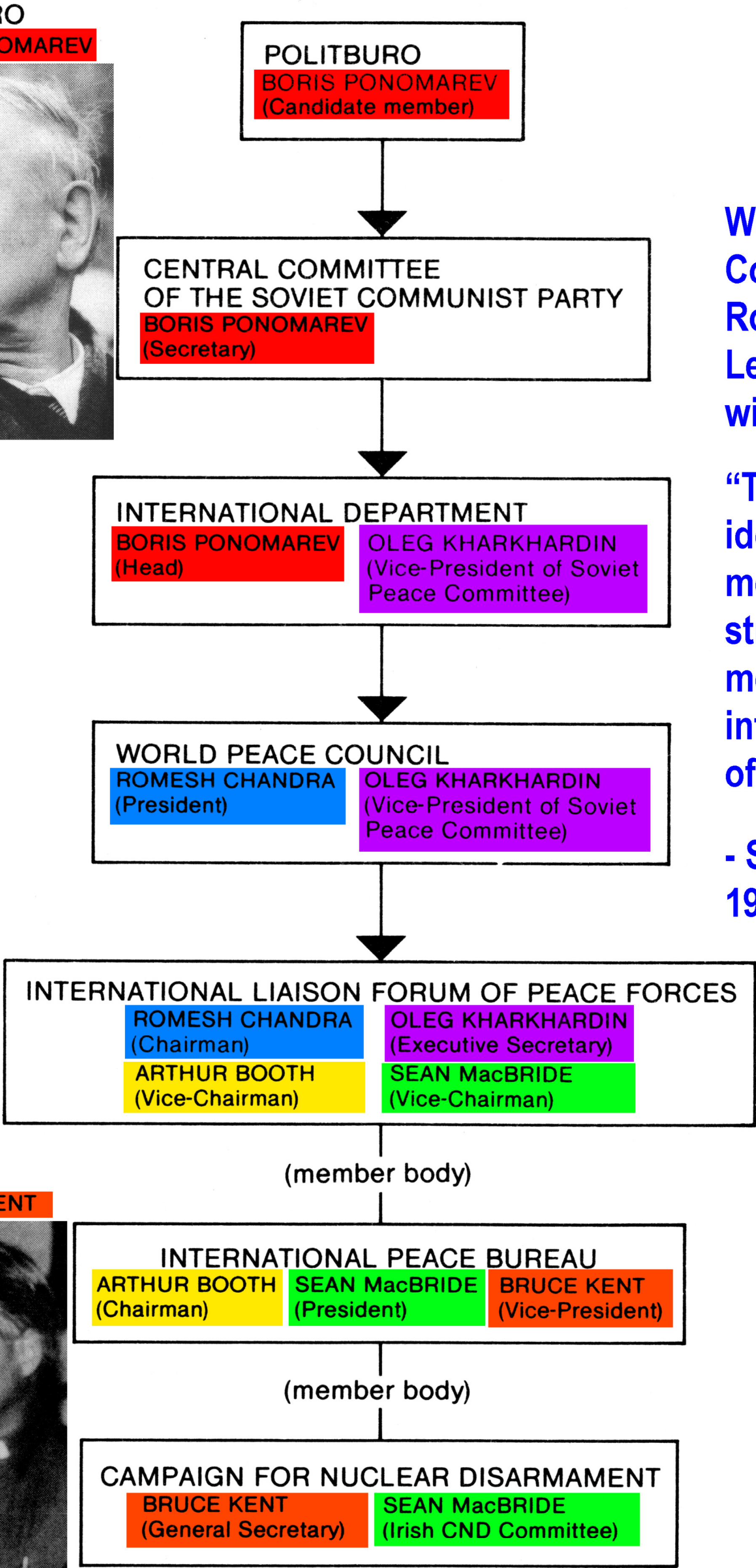
"I personally need no lessons on how to combat 'anti-Sovietism' in the peace movement from armchair peace campaigners. The consistent stand of CND for unilateral nuclear disarmament and withdrawal from NATO has been won by working as Communists in a principled non-sectarian way."—CND Vice-President, John Cox *Morning Star*, 8 January 1985

Paul Mercer, who graduated from Nottingham University in 1982, is a political research consultant and author of several specialist books on military aviation.

The author (*left*) with one of his 'sources', Mgr Bruce Kent—former General Secretary of the Campaign for Nuclear Disarmament.

"I don't condemn the IRA bombings in public—I explain that they are a direct response to British policy—in some situations it's not useful to preach pacifism."—CND Council Member, Pat Arrowsmith *Socialist Challenge*, 4 June 1982

POLITBURO
BORIS PONOMAREV

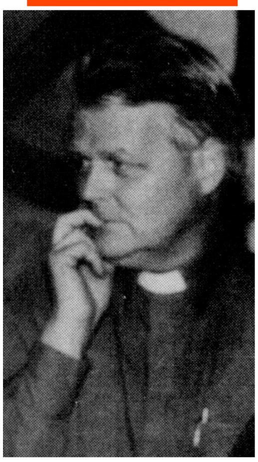



**World Peace Council President Romesh Chandra, Lenin Peace Prize winner:**

**"There is a wrong idea that détente means lessening the struggle ... détente means the intensification of the struggle ..."**

**- Sunday Chronicle, 19 December 1976**

CND
BRUCE KENT



*One of the CND's many links with the World Peace Council in 1983*

**Sean MacBride is a former IRA Commander awarded a Lenin Peace Prize and a Nobel**

# Boris Ponomarev, Politburo

(b 1905, Red Army 1919, Central C. 1956, Politburo 1972)

**Head of the International Department, CCCP**

***Propagandarist inventor of détente appeasement***

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Boris Ponomarev was author of the books "The Great Vital Force of Leninism" and "The Liberation Movement", both Russian propaganda publications sent directly by the International Department of the Politburo to the British National Union of Teachers (NUT) as direct infiltration of Britain's schools. (Sources: John Izbicki, Daily Telegraph, 18 May 1981; Pincher, "The Secret Offensive") <u>Result:</u> NUT's "Teachers for Peace" anti-nuclear lobby for pro-détente school fiction, like "Z for Zachariah".

# HOW MOTHERS LIKE ME ARE DRIVEN TO JOIN THE BIG PEACE DEMOS

*The Cruise missile . . . target for CND fairytales. And (right) a concerned mother on the march.*

# This CND blackmail at our school gates . . .

**by ANN LESLIE**

SO were you there on October 22 ? Were you one of the huge crowd of 250,000 demonstrators thronging Hyde Park ?

**And if you were not there, did you feel a little bit guilty about it ? Did some of that magnificent pre-rally CND propaganda get to you ?**

Because it was indeed powerful propaganda. On Friday morning, the day before the demos, I and other mothers were delivering our tiny sons and daughters to their North London primary school.

This humdrum, happy, chattering little scene in the sunshine was briefly overshadowed by a sudden glimpse of apocalyptic terror in the form of two leaflets handed out to us at the gates.

## Horrors

The first said : 'October 22. Where will you be ?' The second, from the Camden Labour Party, told us why we should be there on Saturday. Cruise missiles, due to be installed in December, will 'make nuclear war more likely. . . .'

*And just in case we mothers were to preoccupied juggling with push-chairs and shopping-bags to understand the implications of that, the leaflets told us what would happen if a one megaton bomb was exploded over Trafalgar Square.*

We live in the 'area north of London Zoo up to Hampstead Heath' and that would mean, among other horrors, '50 per cent. dead from blast (ruptured guts, crushed bones).'

It didn't of course mention that the Soviets already have over 350 SS20s installed, each with three warheads, two-thirds of which are targeted on Western Europe. Information like that might 'confuse' us mothers outside the school gates.

Nor did it mention that most members of unofficial peace groups in Eastern Europe — those not controlled for propaganda purposes by the Soviet authorities — are bitterly opposed to the unilateralist and neutralist ideas of CND.

These Eastern Europeans know the realities of Soviet power, and they know that the West can only hope to succeed in disarmament negotiations if it negotiates from a position of strength.

The message handed out at the school gates had to be kept 'unconfused' by such 'irrelevant' facts.

*And so, yes, those leaflets did have a powerful emotional kick. As I watched my adored little five-year-old cheerfully hurrying into class with her best friend, I felt a sudden lurch in my stomach.*

Those two merry little souls, millions of innocents like them — 'ruptured guts, crushed bones'. Please God, no !

## Declined

So why didn't I join that march on Saturday ? Don't I care ?

Well, it so happens that I was there—not as a demonstrator but as an observer. I was making a film report for Channel 4 on the demonstration which CND now claims is 'proof' that the peace movement has not lost its battle.

I had assumed that everyone in that crowd on Saturday actually knew what they were demonstrating about. But did they ?

Oh sure, they were, as everyone told me earnestly, demonstrating 'in favour of peace and against nuclear war'. Well, you'd have to be criminally insane not to be in favour of peace and against nuclear war. So let's try to take it beyond the infants' class level.

No use pointing out that public opinion as expressed by the people of Hungary, East Germany, Czechoslovakia, Poland and Afghanistan has only influenced the Kremlin into greater spasms of repression and cruelty.

## Destroy

Presumably most of those at the demonstration were convinced by CND's propaganda

Nor is there any illusion at NATO or SHAPE headquarters (where last week I sat through many discussions with men with titles like Head of Nuclear Planning) that America could fight a limited nuclear war in Europe.

As General Rogers, the American Supreme Allied Commander, Europe, said : 'The Soviets have said that any American weapon system being fired at Soviet soil will be cause for her to attack the United States with strategic weapons.'

How many of the people in that crowd of 250,000 have been told any of this by CND ? Very few.

Alas, some of them didn't even seem to know the difference between 'unilateralist' and 'multilateralist'. One nice, earnest young man told me he was there because he was a 'multilateralist'.

## Outbreak

But this, I pointed out, was a demonstration in favour of 'unilateralism'. His response was a look of utter bafflement.

*Many in the crowd used the demonstration to promote a whole variety of separate causes. Like the seller of the Hard-Left newspaper who told me we must 'defend the Soviet Union against Western imperialism.'*

Like those who wanted solar heating in homes. Like the Hare Krishna people who said that meat-eating was the cause of nuclear war.

And like the Greenham women, who were collecting money to finance a 'permanent' peace headquarters.

Not so long ago, they were telling me that the arrival of the first Cruise missile would mean the outbreak of nuclear Armageddon. Since the end of the world is nigh in a few weeks, it seemed odd, to say the least, to ask for money to set up a 'permanent' headquarters.

So all of you who might have felt a twinge of guilt about not 'being there on October 22' — forget it. The majority of those who were there were well-meaning, hopelessly muddled, easily exploited people

1983
Daily Mail

# This battle for your child's mind

by Rodney Tyler


The fact is that most parents, throughout the country, would be horrified if they realised how, even in the basic routine subjects, such as English, History and Science, their sons and daughters are being indoctrinated.

Take a look at the methods employed in sample lessons in at least one school:

An English lesson is based on how the language of the nuclear age is used by the media to condition ordinary people into accepting Cruise missiles.

Then the teacher takes a headline from the sports pages: 'Hammers massacre Coventry in five-goal blitz.' He uses it as the starting point for a discussion which moves on to deplore the way newspapers and TV glory in war and distort the views of those who believe in peace.

Science, before lunch, is easier. The Physics master, in defiance of a request from the Minister of Education, gives the pupils the full benefit of his personal conviction that American possession of a nuclear arsenal is a one-way suicide trip for mankind.

History, in the afternoon, is a study, through books supplied to the school by Novosti, the Soviet Press agency, of Russia's peaceloving intentions over the last 30 years, compared with Western war-mongering.

*A fantasy? Not the sort of school you would dream of letting your child attend?*

No It is fact. And you might soon have no choice but to send your child to such a school.

For there is at least one comprehensive school in Britain where each one of those sample lessons—or ones similar—has already taken place. And there are at least a dozen major local

In Britain's biggest teachers' union, the National Union of Teachers, more than 10 per cent. of delegates at the annual conferences come from just one of the extreme Left-Wing groups operating within the educational system.

But what he feared most of all was the attempt by the notorious Inner London Education Authority to foist on him those that were politically in line with its far-left leadership.

This school year he will be ordered to give more status to

released for special courses in how to combat racism.

Another London head described a visit from one of the proliferating 'advisers' who demanded to know why Irish politics, history, literature, and music were not being taught to the Irish children in his school.

The visitor accused him of 'not co-operating' when he pointed out that he had 30 different nationalities in the school and if he discriminated in favour of one minority he would have to favour them all.

But he sees as far more sinister the question he and ILEA's 170 comprehensive heads were forced to answer recently: 'Do you recognise the role of the "hidden Curriculum" in political education?'

He told me: 'It was rather like being asked if I had stopped beating my wife. If I said yes it would have meant that I was secretly indoctrinating my children, if I said no it meant I was refusing to do so. Either way I would be open to attack.'

The hidden curriculum is another way, in Left-Wing eyes, of influencing children. Put bluntly, it means taking every opportunity as it arises in normal lessons to put across your political message.

*It is this sinister move, which ILEA—Britain's biggest authority—is poised to introduce. Thus, both overtly and covertly they plan a massive programme of indoctrination.*

Printed advice on how to get rid of uncooperative heads which circulates secretly among some of these groups includes such gems as:

- Hold sudden meetings at the most difficult times for the head and his staff.
- Prolong meetings unnecessarily and harass officials of the Board into resignation — then put your own people into their positions

# CND: IS IT ALL A RUSSIAN CON TRICK?

## Moscow's making fools of our ban the bomb brigade

By MARJORY DAVIDSON

**THE 19 Very Important Visitors were welcomed to Moscow in the style of Heads of State.**

Police escorted their motorcade as it swept through red lights on the way from Sheremitovo Airport to a downtown hotel.

Visits to the Bolshoi Ballet, the old Czarist capital, Leningrad and the fabled cities of Tashkent and Samarkand were on the programme.

And it was red carpet treatment all the way.

The cost of this 10 day jaunt? Nothing—save the £190 cut-price air fare from London.

Who were the lucky 19? Not pop stars, or soccer players or even astronauts.

They were members of the Campaign for Nuclear Disarmament and fellow sympathisers.

Lord Brockway, co-chairman of the World Disarmament Campaign, led the party which included respected pacifists Dr Malcolm Dando, of Bradford University's School of Peace Studies, Richard Keeble, editor of The Teacher, and Father Owen Hardwicke, of Iay Christi, the Roman Catholic Disarmament lobby.

They had come to Moscow to talk peace.

But like the hundreds of thousands of ban-the-bomb marchers throughout Europe, they were and are, tragically, just dupes.

They are part of a campaign that is orchestrated and financed by the Soviet Union with the direct purpose of weakening the West, her resolve and her strength, while Russia continues to build up the most fearsome military machine in history.

Take that starry-eyed journey last March. The Russians quickly showed their visitors that they wanted others to talk about peace. They want others to disarm.

The naive band of travellers were campaigning for Britain to scrap all nuclear weapons. When they hesitantly asked the Kremlin to make a possible ten per cent reduction in its nuclear arsenal, the reply was a brutal "Niet."

In Britain, the ban-the-bomb campaign is booming. Membership has increased from 3,000 to 37,000 in 18 months and includes many idealistic young people.

*Last October, more than [illegible],000 people from all over Britain attended the biggest demonstration in London since the heady days of the Sixties.*

## LEFTIES WHO RUN PEACE CAMPAIGN

Brezhnev flew from Moscow to meet the 1,000 Soviet-subsidised delegates in Sofia.

Labour MPs present included Roy Hughes (Newport), James Lamond (Oldham East), Andrew Bennett (Stockport North), William Wilson (Coventry SE) and Alf Lomas (Euro MP London NE).

Alex Kitson, executive officer of the Transport and General Workers' Union, was also among the guests.

In Britain, as CND membership has grown, a Left-wing takeover has emer[illegible]he top.

Idealists have been replaced by militants with potent Euro-Communist connections.

They seek a power base in Britain. They aim to get it by exploiting the fear and horror felt by decent men and women at the idea of nuclear war.

They have formed special sections — Youth CND and Christian CND —to extend their sphere of influence.

They are especially active in trying to persuade trade unions to affiliate to CND.

These are the facts to remember when [illegible] you are impressed [illegible] lovers on the [illegible] Moscow-style.

# September 30, 1938 peace promise:

We, the German Führer and Chancellor and the British Prime Minister, have had a further meeting today and are agreed in recognising that the question of Anglo-German relations is of the first importance for the two countries and for Europe.

We regard the agreement signed last night and the Anglo-German Naval Agreement as symbolic of the desire of our two peoples never to go to war with one another again.

We are resolved that the method of consultation shall be the method adopted to deal with any other questions that may concern our two countries, and we are determined to continue our efforts to remove possible sources of difference and thus to contribute to assure the peace of Europe.

A Hitler

Neville Chamberlain

September 30, 1938.